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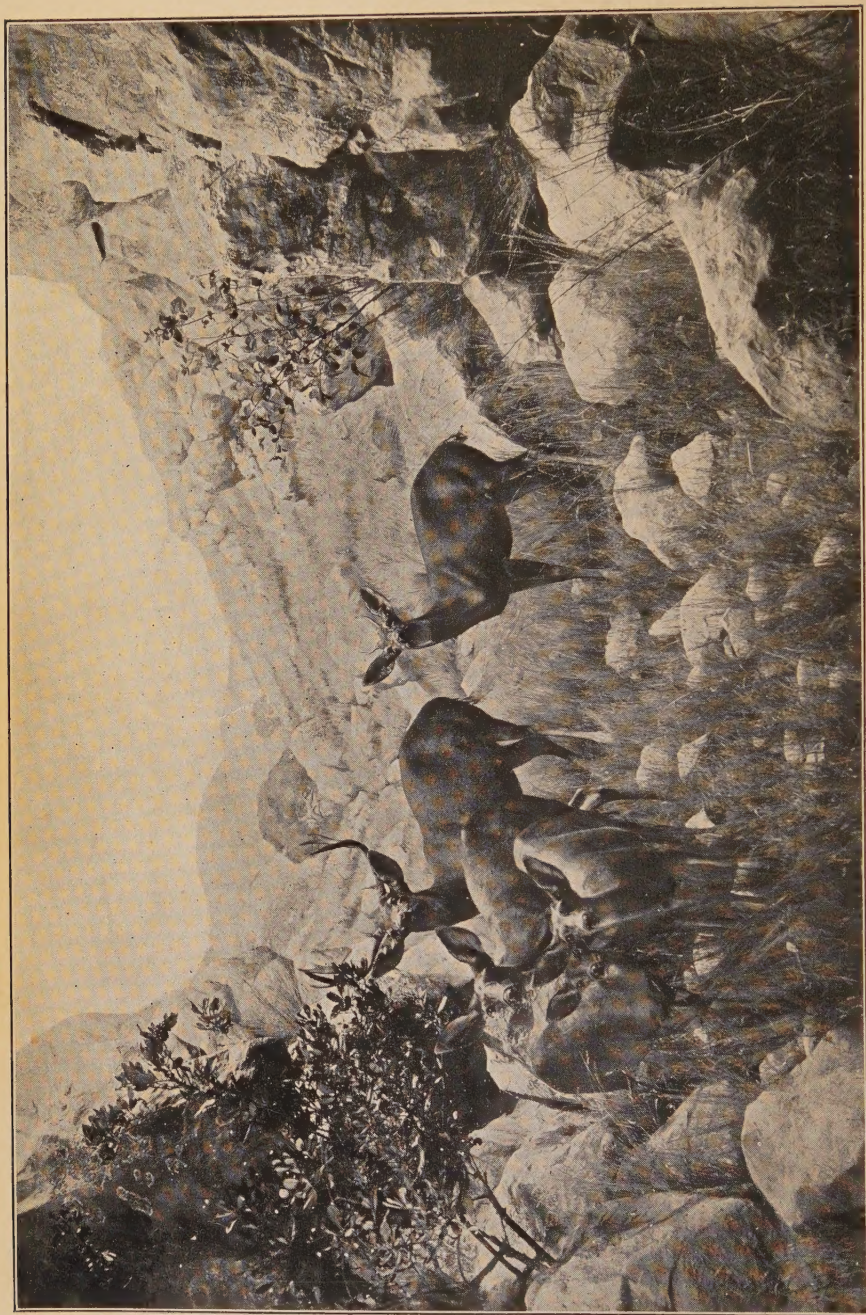


ANNEX

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GROUP OF BLACK-TAILED DEER

TAXIDERMY AND MUSEUM EXHIBITION

BY

JOHN ROWLEY

AUTHOR OF "THE ART OF TAXIDERMY"; FORMERLY CHIEF OF THE DEPARTMENT OF
TAXIDERMY IN THE AMERICAN MUSEUM OF NATURAL HISTORY, NEW YORK CITY; CURATOR
OF MAMMALS AND CHIEF OF EXHIBITS IN THE CALIFORNIA ACADEMY OF SCIENCES, SAN
FRANCISCO; DIRECTOR OF THE OAKLAND MUSEUM; CHIEF OF EXHIBITS IN THE LOS
ANGELES MUSEUM; MEMBER OF THE N. Y. ZOOLOGICAL SOCIETY, LINNAEAN
SOCIETY OF N. Y., AMERICAN ORNITHOLOGISTS' UNION, AMERICAN
SOCIETY OF MAMMALOGISTS, ETC.

PREFACE BY

FRANK M. CHAPMAN

CURATOR OF ORNITHOLOGY IN THE AMERICAN MUSEUM
OF NATURAL HISTORY



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TO

LESLIE SIMSON

CURATOR OF MAMMALS, OAKLAND, CALIFORNIA, MUSEUM,
AND GREATEST OF LIVING BIG-GAME HUNTERS

THIS BOOK IS DEDICATED

AS A TOKEN OF SINCERE PERSONAL REGARD; IN RECOGNITION OF HIS INVALUABLE SERVICES TO FUTURE GENERATIONS IN GATHERING AND PRESERVING FOR MANKIND, ERE TOO LATE TO SECURE THE FAST-DISAPPEARING SPECIMENS, THE LARGEST SINGLE COLLECTION OF BIG-GAME AND OTHER MAMMALS THAT THE SCIENTIFIC WORLD HAS EVER SEEN: MANY OF WHICH WILL ADORN THE HALLS OF THE LOS ANGELES MUSEUM, AND FORM A LASTING MONUMENT TO THE FORESIGHT AND GENEROSITY OF THE COLLECTOR AND DONOR.

PREFACE

Twenty-seven years have past since John Rowley wrote *The Art of Taxidermy*. During this period he has continuously followed his chosen calling, widening his experience in the field, studio and museum, experimenting with new methods in preparation and evolving novel ideas in museum exhibition. With high ideals of the taxidermist's art, and fortunately so situated that he has never been obliged to sacrifice them, his work has always represented the best standards of his profession. His exhibits in the American Museum in New York, the California Academy of Sciences in San Francisco, and the Los Angeles Museum form a notable record of achievement and are a tribute to his standing as naturalist, artist, and craftsman.

But John Rowley can preach as well as practice. Just as his book of over a quarter of a century ago was the best manual of his kind, so this wholly new volume, covering a far wider field, at once becomes authoritative.

There is no phase of his subject with which the author is not thoroughly familiar. Hunting, trapping, skinning, preserving—all the minutiae of the collecting, care, and mounting of specimens are dealt with in great detail. Particularly full are the instructions for making artificial vegetation and other exhibitional accessories, and here will be found original formulæ and information not elsewhere available.

Rowley does not leave his subject with the completion of his work as a taxidermist but discusses at length and in a practical way the equally important matter of exhibition. Here also he can speak with the authority born of long experience. His book, therefore, is addressed not only to his colleagues and to every one who would preserve bird, beast, fish, or plant, but to every one who has anything to do with their display.

FRANK M. CHAPMAN

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AUTHOR'S PREFACE

In former times, taxidermy was carried on by comparatively few men, who were more or less secretive and jealous of their methods of work; and as a result, the technique of the trade was very little known. With the growth of museums throughout the world, however, and the demand for men of both education and genius in preparatory work, these conditions changed, and the world to-day has a far better understanding of the taxidermist's art and its possibilities. The publication, also, of articles on museum work, whether sponsored by a museum or issued independently, has had a good effect in dispersing the old time secretiveness and jealousy, at the same time that it has broadened the field, and elevated the standards and improved the quality of museum exhibits.

My purpose, therefore, in preparing the present volume is to contribute to the advancement of museums and museum work. If the beginner has nothing upon which to build, he must spend his lifetime investigating and developing methods which possibly have been already perfected; and if these improvements have not been published nor made accessible to him, he will have advanced only as far as his predecessors. Whereas, if the beginner starts in where the latter left off, his experience and constant improvement, added to what is already known, cannot fail to elevate the whole.

Fifty years ago, the idea of constructing a museum building for the sole exhibition of a series of groups of birds or mammals would have been ridiculed, and perhaps rightly so, as the crude results then obtainable would not have warranted the expenditure of the necessary money, the methods of preparation not being sufficiently advanced, and the trained operator of to-day not yet having made his appearance. Since then, the introduction in the museum laboratory of the art of modeling artificial accessories, such as wax leaves and flowers and the allied arts, including painting and sculpture, have had much to do with the evolution of the modern museum; and these have grown up together, hand in hand, with

taxidermy and general museum preparatory work, combining for the production of scientific and artistic exhibits. This advancement has been due not only to improvement in methods inside of the museum itself, but also to the development of inventions in lines not directly concerning the museum, but of which the exhibitor has taken proper advantage—the electric light, for one thing, making possible certain features in museum exhibition quite impossible before through other agencies.

No complete treatise covering general museum preparation has appeared since the author's book, *The Art of Taxidermy*, was published in 1898; while with the passage of a quarter of a century, new ideas and improvements in museum methods have crept in, and but few of those described in that volume I am now applying. The following pages, therefore, representing much thought and experiment along new and progressive lines, contain the results of over thirty-five years of actual, practical labors in the museum field; and it is my hope that twenty-five years hence, or even sooner, some one else may have taken up the subject where I shall have left it, even though in doing so he should eclipse this present accomplishment—nothing being further from my thought than to claim that the methods presented here are incapable of improvement. There is always, of course, one *best* way to do anything, and that way I have conscientiously endeavored to find out; and what I here offer simply records my efforts in that direction. I need only add that the formulæ and methods described have all been tested out and used successfully, many of them being of my own devising.

My thanks are due to Mr. John L. Ridgway, the well-known artist, who made the drawings and retouched the photographs that embellish the work; to various esteemed colleagues who, from time to time, have kindly placed at my disposal the benefits of their valuable experience; to my wife, who gave much of her time to typing the manuscript; and particularly to my lifelong friend, Dr. Frank M. Chapman, Curator of Birds in the American Museum of Natural History, New York City, who generously gave his assistance in the final publication of the present volume.

JOHN ROWLEY

Los Angeles Museum

TAXIDERMY AND
MUSEUM EXHIBITION

TAXIDERMY AND MUSEUM EXHIBITION

CHAPTER I

COLLECTING

Guns.—Any work on taxidermy would be far from complete did it not include a few remarks upon the subject of guns and the care of specimens in the field. As conditions and the game to be sought are so varied in different parts of the world, it would not be practical nor necessary to attempt to describe the methods of collecting in different countries nor the guns best fitted to secure the animal life found there.

Pistols, aside from their value as a protection in emergency, are of very little use in collecting. The choice of a rifle will, of course, depend upon the game to be hunted, and even then different men have their individual preferences and will select the rifle they think best to meet their requirements.

The larger mammals and a few large birds will have to be shot with a rifle, aided by traps and poison; but the shotgun secures the bulk of the bird specimens taken on an ordinary collecting trip. For general collecting, a 12-gauge gun is best adapted. A 10-gauge is unnecessarily large and heavy to carry, and a 20-gauge, although light and handy and having equal penetration, has a smaller killing circle. In the hands of an expert shot, a good 20 will do the work of a 12, but the ordinary hunter will make more kills and leave fewer cripples with a 12- than with a 20-gauge gun.

A double-barreled, 12-gauge, hammerless shotgun of any reliable make is therefore the most effective arm for the average collector. If collecting in a region where very large game may be encountered while gathering in small material, in order to be prepared for the former, some cartridges may be loaded with a single round ball.

If properly loaded, these will shoot accurately and have great killing power. Select a round ball that will pass easily through the gun barrel. Load the shell with powder and wads as usual. In order to do accurate shooting with a round ball, it is necessary to encase it in wads inside the cartridge, by cutting holes in the centers of the enveloping wads and fitting them to the ball. The middle wad should be merely a ring and the holes in the others smaller as they approach the top and bottom of the ball. A thin cardboard wad on top is sufficient, and if the shell be of paper, it should be well crimped down.

I have killed many running deer, and animals as large as a moose with 12-gauge shells loaded in this way. While the round ball has not the penetration of the high-powered rifle and is in no sense to be compared with it for long range or big-game shooting, still it has the shocking power and if properly placed the ball will do the work, provided the range be not too great.

For general collecting, cartridges loaded with different sized shot ranging from buckshot to number 10 will be useful. For small birds, always use the smallest sized shot practicable, as large shot breaks the bones and otherwise mutilates a small specimen. In order to prevent this and also to economize in ammunition, at moderate range the auxiliary barrel is an absolute necessity. As it fits into the shell chamber of the gun, like a cartridge, it can not be used in a pump gun. The .32 caliber is best adapted for all around work, and these may be purchased from dealers in taxidermists' supplies, or a good gunsmith can make one. In default of this, if you are a good enough mechanic, make one yourself, as follows:

Procure a box of .32 caliber Ideal W. R. A. center-fire brass shells. These shells are straight-sided, not tapering nor bottle-necked. They are one and three-fourths inches long, hold a good charge, and may be reloaded an indefinite number of times. Select a piece of heavy brass tubing 10 inches long, a trifle smaller in its inside diameter than the outside diameter of the shell. If you can find a piece of tubing of the exact size so the shell will chamber snugly without boring out, so much the better. I have never been able to find this and have therefore been compelled to drill out one end of the tubing to chamber the shell. Take a 12-gauge brass shotgun shell, punch out the primer, and, with the same drill that was used in boring out the tubing, bore a hole in the center of the

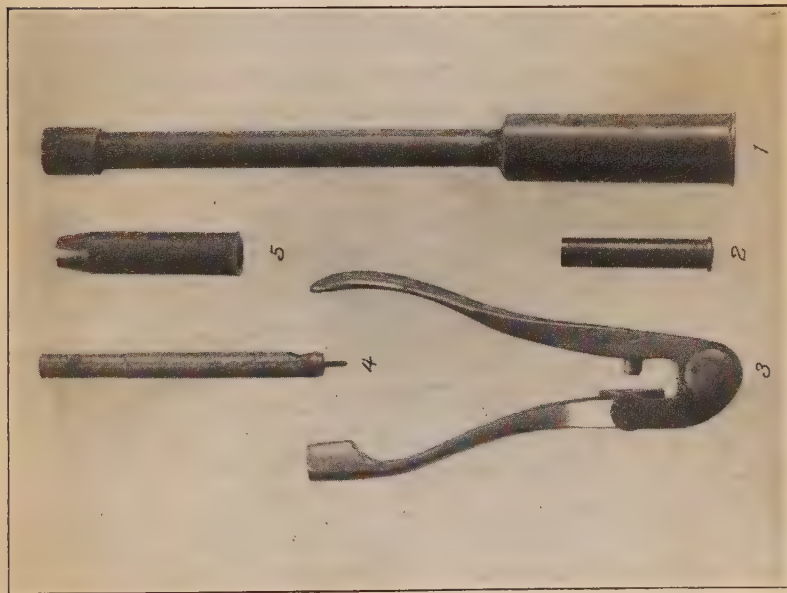


FIG. 1.—Auxiliary barrel and loading tools.
1. Auxiliary barrel. 2. .32 Ideal shell. 3. Recapper.
4. Decapper. 5. Wad cutter.

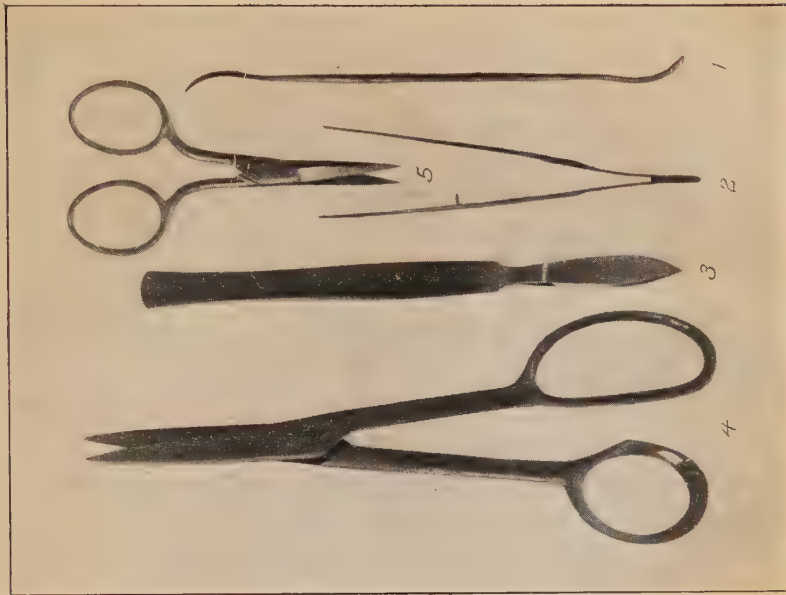


FIG. 2.—Tools used in skinning birds and small mammals.
1. Scalpel. 2. Fine forceps. 3. Scalpel. 4. Large scissors
for skinning birds and small mammals. 5. Small pointed scissors.

base of the shell. Clean and sandpaper the inside of the shell and the chambered end of the tubing, and brush them over with soldering paste or acid. Place a round wooden plug in the hole in the shell, the plug extending a quarter of an inch up inside. Insert the tubing inside the shell so the base of the tubing fits over the plug and rests snugly against the inside of the base of the shell. Stand the whole upright on a sheet of thin flat iron and place over a gas stove to heat. Support and brace the tubing so it emerges straight from the dead center of the shell, and pour the latter full of hot solder. Allow it to remain a few minutes and then turn off the gas and allow the whole to cool. Remove the wooden plug and ream out the edge of the hole to fit the base of the .32 shell.

To choke the auxiliary barrel, select an iron nut with a hole a little smaller than the outside diameter of the tubing, and with a rat-tailed file taper the hole so the tubing will just enter the large end. Place the nut on an anvil or other solid surface, insert the muzzle of the auxiliary, and with a wooden mallet strike the base of the barrel several smart blows. This reduces or "chokes" the muzzle. To reinforce the choke so it won't bulge, cut a ring of brass tubing that just fits snugly over the end, sandpaper and paint with acid, and tin with the soldering iron. Place the ring in position and set on the gas stove to heat, cool off and the auxiliary is ready to shoot, as in Plate I, Fig. 1.

By reason of the expansion and bulging of the shells after firing, they stick in the breach of the auxiliary barrel so that automatic extractors often fail to work. A piece of quarter-inch iron rod used as a ramrod to punch out the exploded shells leaves no room for argument.

The metal of which brass shells are made is elastic and springy. After they are exploded in the gun they swell and must each time be reduced or compressed, before reloading, by forcing the shell through a die with a hole a little smaller than the outside diameter of the shell. This is done by drilling out a nut or other piece of iron and working it to the exact size with a rat-tailed file. This may be determined by forcing a bulged shell through the hole and then trying it in the breach of the auxiliary barrel. To force a shell through, bore a hole in a solid block of wood and set the die over it, or clamp the die in a vise. Brush over the shell with a piece of oiled rag, place the muzzle in the die, cover it with a piece

of hard wood and hammer the shell in all the way down to the rim, thus compressing or swaging it so it will fit easily into the breach of the auxiliary barrel.

A full reloading equipment will be necessary. This includes the Ideal No. I recapper and decapper for .32 Ideal W. R. A. center-fire $1\frac{3}{4}$ inch brass shells, a .32 caliber wad-cutter, powder measure, and loading block; all made by the Ideal Manufacturing Co., New Haven, Conn.

The best materials for loading these shells are No. $1\frac{1}{2}$ U. M. C. copper primers, Dupont smokeless powder, and thick soft leather wads cut out with the wad-cutter. Shot will range from dust to number 10.

With the measure, pour in the powder, force in the leather wads, place the shell in the loading block and give the rammer a good smart blow with a hammer or a wooden mallet to settle the wads down on the powder. The shot is covered with a cardboard wad, and to keep this from loosening and the shot from spilling out, brush in hot paraffine over the wad and the inside of the muzzle of the shell. This solders in the wad so the shell may be carried in a game bag for weeks and never loosen.

The $1\frac{3}{4}$ -inch Ideal shells loaded to the muzzle represent the maximum load and will kill a robin at 25 yards distance. Some shells may be loaded with lighter loads, but what is more convenient is to have smaller loads in shorter shells. The .32 W. C. F. pistol shell, one and a quarter inches long, is well adapted for this, and for very close work as few as a dozen grains of dust shot may be used in a shell.

For collecting small birds, a .22 caliber rifle, with the grooves bored out so as to convert it into a smooth-bore shotgun, and using the regular .22 rim fire shot cartridge, does excellent work and is fine for collecting warblers and humming birds. The penetration is slight and it does not break bones and otherwise mutilate like heavier loads.

A .22 caliber auxiliary made to shoot these shells is also useful for very small birds.

What your gun will do with different loads, and just what load is best suited for each particular need, must be determined by experiment. Every gun has its own distinctive peculiarities and shoots better with some loads than with others.

In order to get perfect results, a gun must be kept clean, inside and out. This is perhaps truer with a rifle than with a shotgun. Before putting away a gun that has been used, it should be thoroughly cleaned, especially inside the barrel. Where smokeless powder is used, a piece of flannel wet with powder solvent should first be forced through the barrel with the cleaning rod.

A good formula for powder solvent is the following:

Amyl Acetate	I ounce
Acetone	I ounce
Sperm Oil	I ounce
Turpentine	I ounce

Mix all together and keep in a stoppered bottle, away from fire.

The barrel should then be wiped out with dry rags, followed by rags saturated with sperm or any good machine oil. When collecting on the sea coast where guns rust quickly by reason of the salt air, they should be kept greased with vaseline or axle grease.

Traps.—In remote regions, Indians and others use deadfalls, pitfalls, and snares; but for general use in trapping fur-bearing animals, steel traps are universally adopted. Descriptive catalogues issued by fur houses give full directions for using steel traps, together with the various scents and baits for attracting animals. These traps vary in size and strength, from the large-toothed bear trap, to the number O, used in catching muskrats.

Museum collectors use, in addition to steel traps, several kinds of small traps for catching mice, shrews, and other small mammals, among them being the ordinary flat rat or mouse traps known as the "Out-o'-Sight," which may be purchased in almost any hardware or house-furnishing-goods store. They work on the deadfall principle and for field mice may be used on runways or baited with a variety of baits. Cereals of any kind are good, particularly rolled oats, and pieces of meat or cheese may be used for shrews. The larger size, known as the "rat trap," is well adapted for chipmunks or small squirrels. A still larger trap of this same type would be admirable for animals of the size of the ground squirrel and muskrat, but they are not made, to my knowledge. These traps must be visited frequently in warm weather, as small mammals decompose quickly after death. The base of these traps, being made of wood, warps after repeated wetting. To

obviate this, a hole drilled crosswise of the grain near each end, and a piece of stiff wire driven in and the ends snipped off flush, will keep the board flat.

In setting a line of mouse traps in the field, a thin copper or brass wire two or three feet long should be attached to each trap in order to tie it fast to some adjacent object, otherwise it is liable to be carried away by some larger animal and lost. The position of each trap, besides being noted on a memorandum card, should be indicated by tying a strip of cloth or a fluff of cotton to a nearby bush or weed stalk. Without these precautions, many traps will be lost.

Field agents of the Biological Survey in Washington, D. C., and many museum collectors have reduced the trapping of small mammals to an exact science and are constantly improving in their methods.

Poison.—Poisons of various kinds are sometimes used in procuring carnivorous birds and mammals, and rodents. Carcasses of dead animals may be slashed and strychnine inserted, or chunks of meat may be split open and poisoned and used as baits. Another method is to use the tallow pellet. Fill a gelatine capsule with two grains of powdered strychnine sulphate, wipe it off after filling so as to destroy any bitter taste of the strychnine that may have gotten on the capsule, and enclose it in a small lump of ground tallow or suet. The lump should then be rolled between the palms until the capsule is entirely enclosed and rendered waterproof. These pellets of poisoned tallow may be dropped around a carcass or along trails, etc., and foxes or coyotes poisoned in this way.

Barium carbonate is much used to destroy rats, and is mixed with grease or other food in the same general way as strychnine. It is, however, slower in its action than the latter. Poison is more useful to the trapper when the ground is covered with snow, for this enables him to track the poisoned animal. Without this many wander off and die, and are never found.

Bisulphide of carbon poured on a wad of cotton or waste and forced down a burrow and the mouth of the burrow immediately filled in with earth, will asphyxiate any animal life that may exist there. An improvement on this is to punch a hole in the mouth of the burrow after it has been charged and stopped up, and light the gas with a torch. The explosion of the bisulphide gas forms

ther poisonous gas combinations and also forces them further into the recesses of the burrow. Bisulphide of carbon, either in the liquid or the gaseous state, is very explosive and poisonous, and should be handled with great caution. Bisulphide gas, like gasoline gas, is heavier than air and flows down into all the windings of the burrow. If the ground be dry and full of cracks, the gas escapes and fails to reach all parts, and this method is therefore suited only to damp ground, or tight burrows. Ground squirrels are extensively killed by this means in many parts of this country. Grain, poisoned by soaking it in a mixture of alkaloid strychnine, starch paste, syrup, and water, is also used for this purpose, but when scattered about on the surface of the ground is liable also to kill other grain-eating animals or birds.

The "smoke gun" advertised by some American fur houses may be useful for obtaining animals in burrows or hollow trees. This is simply a cylinder with a hand bellows at one end and a piece of rubber hose at the other. Sulphur, rotten wood, and other materials that will make a smudge are lighted inside the cylinder and the resulting smoke pumped into the burrow or hollow tree, forcing out the tenants.

Collecting.—The duty of the collector and taxidermist to his specimen begins when he aims his gun at it. If shooting with a rifle, close range makes no difference, but with a shotgun, the farther away a bird may be shot, the less apt it is to be badly mutilated and consequently the less work and cleaning there is to be done on the specimen in preparing it. A bird that is "shot to pieces" is of very little use for anything, except for the cat. The same rule holds good for general collecting.

As soon as a bird is secured, wipe all blood from the feathers with a wad of cotton batting wet with saliva and brush again with dry cotton, always brushing with the grain of the feather and never against it. Acetone, or a mixture of this and carbon tetrachloride, is better than saliva, and a small bottle of this carried while collecting, will save much time later on in the laboratory, as blood will come out of feathers or fur much easier when fresh than when allowed to dry in. Gasoline, especially on water birds, also works nicely in removing blood, either fresh or dry. These all vaporize quickly, and if the feathers or fur be agitated while drying, they

will not need the usual dry corn meal process, described later, to fluff them out.

Open the bill and swab out the throat with a fluff of dry cotton to remove the blood and juices, then insert a fresh wad. The nostrils of large birds should also be plugged. In some cases, plugging shot holes will stop the flow of blood and save time later on. The nicer the condition of the specimen when it reaches the work table, the less work there is to be done on it, and the finer the result. A bird that is all ruffled, bent, and soiled with blood, never can be made as good as though it had been carefully handled in the field; and unless the specimen be rare or difficult to replace, it is better to discard it.

For small birds, make a cone or cornucopia of stiff paper, drop the bird in head first and shake or settle the carcass well into the cone. Bend over the top so the bird will not fall out, being careful not to bend over the tips of the tail or wing feathers. If the shafts of wing or tail feathers be broken, it is next to impossible to repair them; but if they are simply bent or twisted, hold them in a jet of steam from a kettle and they will straighten immediately.

In carrying wrapped birds, do not crush them nor crowd too many into the game bag, as this not only crushes the feathers, but is apt to squeeze out blood and juices and disfigure the plumage. Large birds, such as hawks, are generally carried by the feet, as they are too cumbersome to go into a game bag.

Sometimes a bird is shot and only the wing broken. Instead of riddling him with another load at short range and disfiguring the feathers, or striking him over the head to kill him, grasp the bird with the end of the thumb and finger and compress them firmly under the wings, over the ribs. By this means, the lungs are compressed and the bird soon succumbs.

The treatment of small mammals will depend somewhat upon the length of time that must elapse before they can be skinned, and also upon the temperature. Mice and shrews decompose and "slip," or lose their hair, much quicker than birds, particularly on the belly. If they can be skinned within a few hours after death, they may be carried in whole. This is by all odds the best way. But if the specimen must be kept longer before skinning, it is best to make an opening cut on the belly from the anus to about one-third the way up the body. Peel the skin off both sides so as to

loosen it from the belly walls and sprinkle dry corn meal between the skin and the body. After this, if desired, the belly walls may be cut through and the intestines removed, holding the skin away from the cut and turning the carcass upside down so the blood and juices will run freely and not get on the hair. A wad of cotton or dry grass may then be placed inside to keep the fur from getting wet. This method is sometimes used in collecting rabbits, which spoil quickly. The belly skin is apt to dry somewhat and in the future operation of "making up" the skin as described in a succeeding chapter, it is necessary to moisten the inside of the skin with a wad of wet cotton to relax it before poisoning.

Experience will teach the collector how long different subjects will keep before skinning. A safe rule to follow is that the sooner a specimen is skinned the better, unless it be a bird. These are generally more easily handled if the bird be allowed to become cold so the blood will not run so freely. Fat animals spoil more quickly than lean ones, and the sun shining on a fresh fat skin will slip the hair and epidermis very quickly. I once collected some marmots or woodchucks in the high Sierras in California. They were in rock slides on the mountain sides and quite shy. But by concealing myself and keeping perfectly quiet, first one and then another appeared from holes in the rocks. I shot several and in order not to make any unnecessary noise and show myself, I remained concealed and allowed the dead animals to remain where they fell. After a lapse of perhaps two hours, I proceeded to gather the specimens and was somewhat surprised to find that the first ones shot, being very fat, had been so badly cooked from lying in the hot sun, that the epidermis was blistered and patches slipped off and thus ruined the specimens. The tail of the African lion is very fat and if left in the hot sun for some time will slip in the same way.

A friend who collected elephant seals some years ago told me that the only way he could successfully save the epidermis on the big, fat, oily bulls was to skin them in the surf. If the carcass was high and dry on the beach, the heat from the sun and the sand, and the animal heat in the body, blistered the epidermis so badly that great patches peeled off before the skin could be entirely removed. It depends upon circumstances and the size of the animal as to whether it should be skinned at once where it lies, or be taken

to camp, or to the laboratory, and skinned there. When the skin, skull, and limb bones of a large animal are all that are desired, the specimen may be measured and skinned at once. This is the usual method in collecting.

But in the preparation of a group of black-tailed deer in the Oakland Museum, the specimens were all mounted lying down. Mr. Leslie Simson killed the animals in the mountains about fifty miles distant from the museum, and as soon as they were shot, he removed the viscera and brought the entire carcass to the museum laboratory in an automobile. They were then skinned and the fresh bodies posed and cast in plaster. From these moulds, corrected models in burlap and papier-mâché were made, as described later on, and the skins, after being salted and treated in the usual way, were put directly on the cast models. This saved a great deal of time in the preparation of the model; and by this method, if it be carefully done, great accuracy as regards form and proportion may be secured. Plaster and burlap and the other necessary materials may be taken into the field on special collecting trips and casts of dead animals made there in the same way. In remote regions, this is of course out of the question. Long-haired animals are generally skinned before casting the carcass. Short-haired ones, like a deer in summer coat, or a seal, may have the hair pasted down with a mixture of clay, water, and oil, and after being painted with stearine and coal oil, have the plaster put directly on this. Casts of noses are always valuable aids in mounting, and an opportunity to make one should never be lost. Directions for this will be found in a succeeding chapter.

Penciled outlines of an animal or bird, made by laying the dead specimen upon a piece of paper and tracing around it, are sometimes useful in mounting, and help to secure proper proportions.

As soon as an animal is killed, it should be definitely determined, if possible, just what is to be done with it; whether it is to be mounted and if so what the attitude is to be, or whether the skin is to be used as a robe or rug. The opening cuts will vary according to the purpose for which the skin is wanted, especially in short-haired animals, as seams are difficult to conceal. A chimpanzee skin, for instance, would be about ruined for mounting if cut up the front of the body and limbs. The front is usually the attractive and show side in animals of this description, and the opening

it should therefore be made on the back of the animal. Short-
tailed antelope should not have the back of the legs opened, but
these should be turned inside out in skinning in the same general
way as that recommended for skinning small mammals in a succeeding
chapter.

Tools and Materials.—Following is a list of the tools and materials
necessary to enable the collector properly to skin and prepare
specimens of birds and mammals taken in the field. This may be
reduced or augmented, according to the extent or duration of the
trip and the amount of material that is to be collected.

A pair of good field glasses.

A pocket compass.

A small hatchet.

A small carborundum whetstone.

On extended trips, a carborundum wheel, with hand-power at-
tachment, for grinding knives and hatchets. This is made to clamp
to the end of a table, and is for sale generally in hardware stores.

An extra carborundum wheel of finer grain than that usually
applied, is better for grinding knives.

A piece of sole leather, about twelve by two inches, the rough
side oiled and dusted with powdered emery or carborundum. This
is used to strop knives after grinding, to produce a keen edge for trim-
ming around the noses, etc., in finishing skins.

A long-bladed butcher knife.

Half a dozen shoe knives, the ends ground to a point, for gen-
eral use in skinning.

Two pairs of pointed scissors—large and small.

One pair of pliers—combination flat and cutting.

Two scalpels—large and small.

One pair four-inch forceps.

One pair eight-inch forceps.

One small and one large scraper. A description of these will
be found in Chapter II, under the heading of tools and materials.

One curriers' knife, complete with finger steel, turning steel,
and shaving blades.

Half a dozen hack saw blades of different sized teeth, to use
with the curriers' knife in removing fat from small animals.

A shaving beam, or, in default of this, a half-round post, to be

set firmly into the ground, or the base nailed fast to the trunk of a tree.

A leg iron for skinning shanks. A description of this tool will be found in the chapter on large mammals.

A small flat file.

A steel comb.

A pocket aneroid barometer for taking altitudes.

Cotton thread, Nos. 6, 25, and 60.

Three-cornered skin needles, Nos. 000, 0, and 3.

A couple of papers of pins.

A pencil and notebook, with a calendar pasted on the inside cover.

A millimeter rule to measure small mammals.

A tape measure. Dividers or calipers.

A number of labels, strung, for labeling birds and small mammals.

A square foot of thin sheet lead, a leather punch, and a set of stenciling numbers, for making numbers to attach to large specimens.

In place of lead numbers, flat pieces of wood, wet, and written upon with an indelible lead pencil, are highly recommended for field use.

A blow pipe and egg drill—if eggs are to be collected—and suitable boxes for the reception of eggs.

Twine—heavy and light.

Alum and arsenic, mixed dry, one-third alum, in a tin box with a large screw top.

A small canvas game bag.

A stout tin box—a fishing tackle box is ideal—about 8 x 6 x 6 inches, with a hinged cover. This will hold the small tools, the arsenic can, needles and thread, etc.

Galvanized or brass wire, Nos. 18, 20, 22, and 24, for tails of small mammals.

Matches—previously soaked in hot paraffine to make them waterproof.

A good supply of candles. A couple of coal oil lanterns and a supply of oil, or acetylene lamps, will take the place of candles; but some artificial light is a necessity as much skinning, etc., must be done at night.

Plenty of dairy or table salt.

Casting plaster for making casts of noses, etc.

Yellow corn meal.

Acetone and a tooth brush for cleaning fur and feathers.

A small hand saw.

A film camera.

Cotton batting, absorbent cotton for tails.

"Excelsior" or wood fiber.

A painters' duster for fluffing feathers after cleaning.

A brain hook for large mammals.

Burlap and a sack needle.

A copy of Ridgway's *Color Standards*¹ to enable the collector note the colors of the eyes, bills, and legs of birds, and the fleshy parts of some mammals and reptiles, foliage, flowers, etc. If large skins and bones are to be a long time in transit, Cooper's Dip, or A. Hide Poison should be taken for dipping, to keep out vermin.

¹ *Color Standards and Color Nomenclature*, by Robert Ridgway (A. Hoen and Co., Baltimore, Md., 1912).

CHAPTER II

DIVISION I

TOOLS AND MATERIALS USED IN TAXIDERMY

Workroom or Laboratory.—It may be well to make a few suggestions upon the subject of the workroom, or laboratory. This will vary, of course, according to the amount and character of the work to be done. A laboratory for the manufacture of foliage or one for mounting birds and handling small objects, naturally does not require the space nor equipment necessary for mounting large mammals. If possible, provide yourself with a room where you can be entirely alone or with only the necessary assistants, and where you need not be afraid of "making a little dirt." The room should be well lighted with side windows and, if possible, a skylight for top light. The latter is almost essential in modeling large animals that are to be exhibited in top light. For large mammal work, the room should also be large so as to give plenty of distance in which to study the pose, balance, and modeling. If too close, it is impossible to get the proper effect of these things. Artificial light for night work or dark days should be part of the equipment.

It is not intended that the following list take in everything used in museum preparatory work. Such a list would be unnecessarily cumbersome and tiring.

Running water and a sink are not essential, especially for small work, but are a great convenience.

A stove or other heating device is a necessity, as no person can do his best work if physically uncomfortable. For accessory work in wax, the room should be kept at a temperature of about 70° F. If too cold, wax cracks in handling; and if too warm, it sticks to the fingers and tools.

A gas stove for heating glue, wax, and other materials is almost a necessity, and much more convenient than an electric or an oil stove.

A table and chairs, to be placed where the best lighting is obtainable, close to a window and under a skylight being ideal.

A solid work bench, upon one end of which is fastened a good strong vise. The bench may be fitted with pull drawers to hold nails, screws, bolts, nuts, etc.

Shelving according to the space required for storage.

One or more "built in" dust proof cases with shelves and glass doors, to store mounted birds, accessories, etc., to protect them from dust.

The wall back of the work bench should have a space 10 x 6 feet boarded up tightly. Upon this space should be carefully arranged and hung on nails or hooks the tools that are in general use, such as the following: saws—rip, crosscut, keyhole, and hack—ratchet, hammers, boring brace, ratchet breast, and hand drill, draw knife, carriers' knives, wrenches, mallets, square, etc. Each tool should be traced around, or outlined, on the board surface with a heavy broad line, so that after being used it may be readily put into its proper place; and also so that if a tool be missing it may be noted at once. It is a great convenience and time saver when working to be able to put your hand immediately upon any desired tool.

Small tools, such as pliers, screw drivers, chisels, trowels, and modeling tools may be arranged to slip into holes sawed in a long strip of wood nailed fast to the wall.

Tin cups, modeling palettes, coils of wire, etc., may be hung on nails along the edge of the shelving.

The small tools listed in the previous chapter will also be necessary, supplemented by boring bits and twist drills of various sizes.

The small scraper shown in Plate I, Fig. 2, is invaluable for scraping dry bird skins, setting eyes, etc., and will have to be made by the preparator. Take a piece of steel wire, about the size of round umbrella wire, about six inches long. Place the ends, one after the other, in a gas jet and when red hot, hammer them flat and bend them up as shown in the plate. File one end round like a miniature spoon and point the other. A larger size of this same general shape is also useful for many purposes.

Among the materials commonly used may be mentioned the following:

An assortment of wire and Norway iron rods.

Lumber as required.

Casting plaster and open-mesh burlap.

Artificial eyes, and globe eyes for hand painting—to be ordered from the catalog of the manufacturer.

Turpentine, boiled oil, white Damar varnish, hard oil finish, an assortment of brushes and tube oil colors, the following being commonly used: zinc white, black, Vandyke brown, lemon yellow, cadmium yellow, orange, vermilion, burnt and raw sienna, Indian red, burnt and raw umber, Prussian blue, and Alizarin crimson. From a mixture of these, almost any desired tint or shade may be produced.

Bleached beeswax and Japan wax, paraffine, carpenters' glue, and LePage's liquid glue.

Gum arabic.

Wood or paper pulp, for making papier-mâché.

"Winding cops." This is a fine, soft thread and is perfectly adapted to winding and binding down the plumage in mounting birds. It is for sale by dealers in taxidermists' supplies.

Shellac, orange and white.

Modeling clay; and plasteline, for sale at art stores. Plasteline, or composite clay, is a soft modeling composition, and is the material generally used by sculptors for making small models, as it does not dry out during the progress of the work like ordinary potter's clay. After a model has been cast, the plasteline may be used over and over again for making other models. The incorporation of vaseline with old hard plasteline puts it in condition for modeling again.

Gasoline, acetone, and carbon tetrachloride.

Finely ground cork or fine sawdust.

Curriers' beams, crutching frame, and crutching knife for skins.

In addition to all this, it is a great convenience and time saver to be equipped with electrical power to run a grindstone, carborundum wheel, lathe, drill, and if any fur-dressing is to be done, a drum for fur-tanning and cleaning skins.

For the manipulation of an air brush, compressed air is necessary and foot power is too slow. A large tank for compressed

air is useful for blowing out and cleaning feathers and fur, and for spraying various liquids, such as hot wax or paraffine, paint, varnish, etc. All this requires power, and that supplied by an electric motor is the most convenient and reliable.

DIVISION II

COMPOSITIONS AND FORMULÆ

1. Tan Liquor, or Pickle, for Preserving Hides in a Wet State

Water	1 gallon
Salt	1 quart
Sulphuric acid (commercial)	1 fluid ounce

Dissolve the salt in the water by stirring. Hot water will not take up any more salt than cold. When all dissolved, add the acid, pouring it in very slowly and carefully, so it won't spatter.

This pickle is sometimes useful for immersing large hides that are to be shipped. They may remain in it over night, or a week or so without much injury to the skin. All skins deteriorate, however, from the moment they are immersed, and the longer they remain the more worthless they become. Salt brine will change certain colors in hair, especially yellows and reds, and for this reason skins of these colors should never be immersed. Painting on the flesh side generally answers for small or furred skins and this should always be done where the skin is to be used for comparison in a research collection, if pickle must be used.

2. Salt and Alum Pickle

Water	1 gallon
Salt	1 quart
Alum (aluminum sulphate)	1 pint

Bring to boiling point and cool.

This pickle is useful in humid tropical climates to preserve skins until they can be gotten out of the country, but has the same disadvantages and deteriorating effects as Formula 1.

Alum used in a pickle like this unnecessarily hardens and plumps a skin, and those that have been immersed for any great length of time are practically worthless for mounting or research purposes.

Painting it on the flesh side of the skin is generally all that is necessary.

3. Tan Liquor for Fur-dressing

Water	1 quart
Salt	1 pound
Alum (aluminum sulphate)	1 pound
Dissolve by heating, cool and add:	
Sulphuric acid (commercial)	$\frac{1}{2}$ fluid ounce
Formic acid	4 fluid ounces
Hyposulphite soda	4 ounces
Flour (dry)	$\frac{1}{2}$ pint

Formic acid may be left out entirely and replaced by the same quantity of sulphuric, but sulphuric acid has a tendency to burn or rot skin fibers, while formic acid does not. It is therefore recommended that the quantity of sulphuric acid in tan liquor be reduced to a minimum. Formic acid, however, takes longer to strike into a skin than sulphuric, and plenty of time should be given for the tan liquor to act. Too long is better than too short a time, and the tan liquor will do no harm if left on a painted and rolled-up skin for a week.

3a. Fat Liquor

Water	1 quart
Laundry soap, sliced	$\frac{1}{2}$ cake
Stearic acid, shaved	the same bulk as the soap
Carbonate soda	1 ounce
Neat's-foot, cottonseed or castor oil ...	4 fluid ounces

(Castor oil gives fine results, and is easily obtainable.)

Boil and stir until dissolved, then add:

Ammonia (commercial)	1 tablespoonful
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The soap and stearine emulsify the oil. This is to be used warm, painted on the flesh side, after the tan liquor 3. One application is sufficient for a thin skin, and two for heavier skins. The soda and ammonia neutralize all acids in the skin, as sulphuric acid will in time rot a fur-dressed skin if allowed to remain. No matter how well a skin may be tanned with any tanning formula, it will not be soft and pliable when dry unless "fat liquored," as the oil lubricates the skin fibers and allows them to slip easily one upon another. There is also a great difference whether a skin be oiled or fat liquored wet or dry. Oil placed on the inner surface of a dry tanned skin remains on the surface and is always greasy, while if

put on a wet skin, it strikes in and disappears, leaving the surface dry. It should therefore always be used on a wet skin. Skins that are not to be mounted after tanning may be tanned with a combination fur and chrome tannage, by adding bichromate of potash to the tan liquor, and leaving out the hypo. This should be painted lightly on the flesh side, so as not to stain the hair, and two or more coats given. Bichromate stains on hair may be removed by painting with dilute sulphuric acid. Hypo may then be added to the fat liquor for this combination tannage.

4. Arsenical Solution for Poisoning the Inside of Relaxed Hides before Mounting

B. A. Hide Poison, in paste, known also as "Veneno," manufactured and sold by the George A. Erkenbrach Co., 115 Maiden Lane, New York City, when reduced with water according to the directions on the can, is highly recommended. This is extensively used in hide warehouses to protect dry cow hides from dermestids, or skin beetles. In default of this, white arsenic (arsenious oxide) mixed with water and carbonate of soda and boiled (sodium arsenite), is a soluble form of arsenic and does better work than white arsenic mixed directly with water. In the formulae given for arsenical soap in other books, arsenic is the active poisoning agent, the other materials being simply vehicles for its distribution. Painting or dusting arsenic on the flesh side of a skin helps somewhat to keep out injurious insects, but there is nothing known which when placed on the flesh side of a skin will positively protect the hair or feathers from insect pests. It may protect the skin itself but not the outer covering.

5. Poisonous Materials Used to Protect Dry Skins from Insect Pests

A composition somewhat similar to Cooper's Dipping Powder, and one which answers the same purpose for dipping or poisoning dry hides, is about as follows. It may be evaporated to powder form for convenience in handling if desired.

Flowers of sulphur	3 pounds	12 ounces
Arsenic sulphide (yellow arsenic)		10 ounces
Sodium arsenite solution	1 pint	4 ounces
Gum arabic, of medium viscosity, dissolved in water		2 ounces

If arsenic sulphide can not be procured, arsenic disulphide (red arsenic) may be used. The latter is used as a depilatory in tanneries and is easily procurable from dealers in tannery supplies.

The sodium arsenite solution is previously made up as follows:

Arsenic trioxide (white arsenic) ...	$\frac{1}{4}$ pound
Carbonate of soda (washing soda) ..	$\frac{1}{2}$ pound
Water	1 quart

Boil for an hour, stirring occasionally.

Place the sulphur, dry arsenic sulphide, and liquid gum arabic in a mortar, together with a small quantity of the sodium arsenite solution and grind them together, adding the balance of the sodium arsenite in installments and grinding until the paste is homogeneous.

For dipping skins, 1 quart of the stock, as given in the above formula, should be diluted with about 20 gallons of water.

Formula 4 may be used for dipping dry hides to keep insects from destroying them. Cooper's Dip, which is an animal dip used for killing vermin on live domestic animals, is much used in Africa for dipping skins and is also good. A mixture of the two is stronger than Cooper's Dip alone. If dry hides be immersed for a moment and well dried out again before packing for shipment, they are pretty safe from bugs. If the skins be thin and soften up after dipping, they should be resalted and then thoroughly dried out. If not bone dry when packed they are liable to sweat and mould and ruin the skins, especially if packed in air-tight zinc-lined cases.

Formula 4 may also be used to poison the exterior of mounted specimens that are infested with moths or dermestids. Such specimens should first be sprayed or painted with gasoline to kill any insect life that may exist in the hair. When this has evaporated, spray or paint with Formula 4 diluted with water. Bichloride of mercury solution, as follows, is also used to spray infested mounted heads or entire specimens, after the gasoline treatment.

Water	1 gallon
Citric acid (dry)	2 ounces
Bichloride mercury	4 ounces

Dissolve the citric acid in the water and then add the bichloride and stir well.

This solution is very poisonous and great care should be used in the mixing and application of it. For that reason it is seldom

used except for poisoning large mounted specimens or heads that are unprotected by glass cases, and already infested with moths or dermestids. Naphthaline flakes, or "moth balls," laid inside a can or box, while not poisonous, act as a repellent to insects. Naphthaline plentifully sprinkled into the box in which skins are shipped is a safe preventive against the entrance of insects while the odor lasts.

Study skins of birds and mammals that are kept stored in airtight zinc or tin cases, are usually fumigated with bisulphide of carbon whenever the presence of insects is suspected. A little of the liquid may be poured upon a wad of cotton or waste or into a saucer and allowed to evaporate inside the closed can. The resulting gas is very poisonous and asphyxiates any insect life that may exist in the can. When the can is opened, it is wise to open the windows of the room and allow plenty of time for the escape of the gas. Like gasoline, the liquid and gas are both explosive and should be kept away from fire. The gas is heavier than air and flows downwards and will not penetrate thick, dense substances. For these reasons, bisulphide is not adapted to poisoning the contents of large rooms. The more volatile but even more poisonous gas produced with cyanide of potassium and sulphuric acid is used for this purpose. The method of application is given under the heading "The Treatment of Skins" in Chapter V.

Large fur houses are equipped with a cold storage room for valuable furs in which the temperature is always kept just below freezing point, thus checking the ravages of insects and being accessible at all times, without the use of poisonous or odorous gases.

6. Dry Arsenical Mixture for Poisoning the Interior of Small Fresh Bird and Mammal Skins

White arsenic (arsenious oxide) . . 3 parts
Powdered alum (aluminum sulphate) 1 part

More alum may be used in humid tropical climates, and less in dry regions.

Mix, dry, and apply as a powder with a bristle brush or wad of cotton to the inside of the fresh moist skin. Should the skin surface be dry so the poison will not cling, dampen the skin with a wad of cotton and water, then apply the dry powder. For large

birds and mammals that are to be made up or mounted fresh, the powder may be mixed with water and painted on. This not only does better work but is safer to handle and more economical as the loss by sifting out is not so great.

This mixture is the one generally used by collectors in all parts of the world for preserving skins of birds and small mammals for research and other collections.

Some preparators have decried the use of arsenic in any form as being not only dangerous to handle, but holding that it is not necessary and that other non-poisonous substances are just as good. Any prospective collector who thinks thus can find out the truth of the matter to his entire satisfaction by offering for sale to any well-known museum, a collection of bird skins together with the statement that no arsenic nor other poison was used in the preparation of the specimens. Unless they are very rare, the collection will in most cases be refused.

I once saw a drawer of bird skins that had been made up with the use of pepper or some such substitute for arsenic, put away in a museum storage can, along with drawers or trays of skins that had been treated in the usual way with arsenic and alum. The can had been overlooked in the periodical examination for insect pests, for a year or more, and when finally opened, the tray of unpoisoned skins was found utterly ruined by moths and dermestes while not one of the poisoned skins had been touched.

A specimen that has been carefully cleaned of all superfluous flesh and fat is much less liable to the attacks of insects than one that has been slighted in the preparation, even though the same kind and quantity of poison be used on both.

7. Alcohol and Formaldehyde Solutions for the Preservation of Small Specimens Entire, to Be Used as Subjects for Anatomical Study or Skeletons

Commercial grain alcohol (95 per cent) 4 parts
Water 1 part

The fur or feathers should be thoroughly soaked before immersion. Small mammals immersed in this solution, if opened on the belly and injected with a syringe before immersion, will generally skin and mount, or be suitable to make up into study skins

at a later date, provided they have not remained in the solution too long. It is, however, safer to consider all alcoholic specimens as material for anatomical study. In time, alcohol or any other known liquid will bleach out the colors of feathers, hair, or skin, the intensity of the light to which they are exposed being a determining factor. Alcoholics should therefore be kept in a dark room, as they are of no use as an exhibition collection.

Small reptiles when captured are generally dropped alive into the alcoholic solution. When dead, they are removed and injected with the solution and again placed in the jar or tank. As the liquid becomes discolored through use, it should be changed for a fresh supply.

Formaldehyde.—Formaldehyde, known as formol, formalin, etc., is also used instead of alcohol for the preservation of entire specimens to be used for anatomical study. Any specimens desired for subsequent use as skeletons should be kept out of formaldehyde solutions, as this liquid hardens flesh and tissues, and renders them insoluble in water or any other known liquid.

On account of its cheapness and condensed form, formaldehyde is much used in the field, the specimens being transferred to alcoholic solutions upon their arrival at the museum. For preserving specimens, dilute one part of commercial forty per cent formaldehyde with about nine parts of water. At first, specimens should be covered by at least double their volume of fluid. After they are thoroughly impregnated, less fluid is required and more specimens may be placed in the same tank. As with alcohol, the fur of mammals should be well wet with the solution, and a stronger solution—say one to four—injectd through the mouth, anus, and abdomen. Formaldehyde is a most unpleasant medium in which to work, as the liquid irritates the fingers and the fumes inflame the nose and eyes.

For larger specimens the embalming method is used, for the reason that when a large specimen is submerged, the fluid does not penetrate to all parts quickly enough to stop decomposition; whereas if the fluid be injected into the main arteries, it is quickly and evenly distributed all over the body. Glycerine or salt, or both, may be used with the preserving fluid to prevent the tissues from becoming too hard. After embalming, a specimen may be submerged in the usual manner, and after it is well pickled, it may be

placed in sawdust wet with the solution, packed in a tight container and shipped. Upon arrival at its destination, it should be again submerged in an alcoholic or formalin solution for permanent storage.¹

8. Formula for Liquid Celluloid, and Celluloid Films for Representing Water, Casting Leaves and Other Objects

Amyl acetate	2	gallons
Fusel oil (U. S. P.)	1	gallon
Benzine	1½	gallons
Wood alcohol (95 per cent)	1½	gallons
Castor oil	2	pounds
Soluble cotton (gun cotton)	2½	pounds

A smaller quantity of the solution would be about as follows:

Amyl acetate	8 2/3	ounces
Fusel oil	4 1/3	ounces
Benzine	6 ½	ounces
Wood alcohol	6 ½	ounces
Castor oil	6	ounces
Soluble cotton	1 ½	ounces

The addition of more castor oil makes a softer film, and *vice versa*. Although not explosive when made up, this mixture, both the liquid and when dried out in the form of films, is highly inflammable, and should be kept away from fire at all times.

To make up the solution, first mix the liquid ingredients, then put in the cotton. Stir just to wet the cotton then allow the whole to stand a day. Stir thoroughly and keep in stoppered bottles or jars. Before using, strain through cheese cloth and allow it to stand a few hours to permit all bubbles to settle. If it is desired to use some liquid that has stood a long time, stir it well, strain, and allow the bubbles to settle. This makes a fine transparent varnish for many purposes, is perfectly waterproof, and will not turn yellow with age. The solution may be colored to any desired tint by the addition of tube oil colors. For transparent films or casts, the liquid may be dyed with oil dyes, or water dyes dissolved in a minimum of boiling water and then diluted with acetone, strained and added to the liquid celluloid formula. Instead of using the

¹ For a detailed description of formaldehyde embalming and the methods of procedure, see "The Preparation and Preservation of Anatomical and Embryological Material in the Field," by Adolph H. Schultz (*Journal of Mammalogy*, Vol. V, No. I, p. 16. Feb., 1924).

liquid formula, ordinary sheet celluloid may be dissolved in acetone to any degree of viscosity, dependent upon the proportions of the ingredients. Clear sheet celluloid may be used, or it may be purchased, under the name of "Pyralin," ready colored with dyes and paint pigments, direct from the manufacturers, E. I. Du Pont, Nemours & Co., Wilmington, Del. This solution dries much faster than the regular celluloid formula, owing to the rapid evaporation of the acetone solvent, and the lack of heavier oils. When used for casting as later described, the finished product is also much smoother and harder, and finer definition may be secured than with the regular formula.

The addition of gum copal to liquid celluloid makes a more viscous liquid and adds bulk. It is therefore an advantage in casting celluloid leaves and fruit as later described, as fewer coatings are required. Grind up the gum in a mortar, add it to the celluloid and stir occasionally until it is dissolved. After straining through cheese cloth, the liquid is ready for use. This material when cast into the form of leaves or other objects, takes liquid dyes readily. A quick easy method of securing a transparent green color for leaves, by transmitted light, is to cast them in clear uncolored celluloid, and, when dry, dip, spray, or paint them with water dyes. The surface coloring may then be varied as desired with oil colors.

To prepare a celluloid film to represent water in a group, take a piece of plate glass of the requisite size and wash and wipe it perfectly clean. With a wad of cotton, rub the glass with talcum powder and wipe off the excess. Surround the glass with a wooden frame, the edges projecting half an inch above the glass all around and saw a small hole or slot in each corner. This tray or frame will stiffen the glass and makes it easier to handle. Pour slowly enough of the liquid along the top of the tilted glass to spread evenly all over the surface and allow the excess liquid to drip into a can from one corner. Allow a day to dry. Then flow from the other end and allow the liquid to drain off from the opposite corner, thus equalizing the thickness of the film. Six or more flowings may be given according to the thickness of the celluloid sheet desired, allowing a day for drying between coats, and dusting the dry surface each time, before flowing with a fresh coat. If air bubbles form during the flowing operations, puncture them with a needle while fresh and they will disappear. After allowing several days for the film

to become thoroughly hard and dry, cut all around the edges with a knife, and strip the film from the glass.

If a large plate of glass is not available, celluloid films may be made on a wooden surface coated with gelatine as follows:

Nail and glue together seven-eighths inch tongue-and-groove clear pine boards. Plane and sandpaper the surface and surround the edge with a raised strip or bead tacked on, for flowing. Flow the boards with water and drain it off. Make a moderately thick solution of gelatine by cooking in the water bath about two pounds of gelatine to a gallon of water. Strain through cheese cloth, and skim all bubbles from the surface. Allow the gelatine to cool a little and flow the wet boards in the same way as already described for flowing liquid celluloid. Repeat the coatings until a glassy surface results. When thoroughly dry, rub with talcum powder and otherwise flow and build up the film as on a glass surface.

Films for a water group should be stretched and tacked across the prepared tray or base of the group while fresh. If allowed to become dry while rolled up, it is almost impossible to again make it lie flat. The advantages of a celluloid film over glass for representing water are that there is no danger of cracking the film in ordinary handling, and any number of holes may be drilled or cut in the film to accommodate swimming birds or accessory matter. A group representing cat-tails and rushes growing out of the water is easily done by the use of the celluloid film, but would be impossible with a plate of glass. For groups where it is desired to represent large expanses of water, celluloid sheets may be joined at the edges and these concealed with floating sticks, wax scum, artificial plants, grasses, and swimming birds.

But where a group is to be viewed only from a distance, large water expanses are better represented by discarding the celluloid film altogether and substituting fine-mesh wire cloth, or netting, surfaced with varnished tissue paper, as follows:

Build a wooden frame in the group to the general depth and outline of the required pool or pond, making the upper edges of the frame level all around. Cover the bottom with wire cloth and with a trowel spread on thin papier-mâché containing plenty of dry Vandyke brown to represent mud, and allow this to become thoroughly dry.

Tack wire mosquito netting across the frame, stretching it

lightly in all directions and paint it the same color as the bottom make it disappear. Allow the paint to dry. Dilute fresh white shellac with alcohol and pour it into a long tray or trough. Immerse long sheets of white tissue paper in the shellac and allow them to remain fifteen minutes. Take hold of one end and lift each piece slowly out of the liquid, thus giving it a thin even coating. This makes the paper transparent when dry. While wet with the shellac, lay the paper on the wire netting and with a wide flat brush varnish it with white Damar varnish, working out all wrinkles and bubbles. A little blue color may be mixed with one coat of varnish to represent sky reflection, and several coats of varnish may be applied as work progresses on the group. Good results may also be produced by painting both the netting and bottom bluish.

Model the water line of the bank or mud flat to meet that under the water. As many holes as desired may be drilled through the paper and netting, as with celluloid. To represent fresh mud, mix turpentine or carbon tetrachloride with brown-colored wax and paint it, hot, over brown dry mâché. In some instances the waxing is best done after the accessories are in place, the wax joining them closely at the base. The wax may be daubed on the bases of some of the aquatic plants higher up on the stalks to imitate floating dirt that has been deposited after the water receded.

9. Wax for Making Artificial Leaves, Grass, etc.

Bleached beeswax	1 pound
Rosin, powdered ("water white")...	1 ounce
Boiled linseed oil, by measure	1 ounce

Melt the rosin in a sand bath, made in pressed, not soldered, vessels, the same as a double boiler, the water in the lower vessel being replaced with sand. A much greater heat may, of course, be gotten with the sand bath than with water, without danger of burning the composition as often happens when a single vessel is used. When the rosin is melted, add the linseed oil and stir well. It is a good plan to make up a quantity and allow it to cool and keep it as stock. When at a temperature of about 70° F. it should have about the consistency of molasses. It may be added at this consistency to hot wax and stirred in. Two tablespoonfuls to a pound of melted wax is about right for tempering wax for ordinary work. The more rosin and oil that is added, the softer and

stickier the wax. By mixing in dry soapstone, this makes a fine putty for finishing mounted mammals, filling open seams, etc. It may be colored by the addition of tube oil color.

To color the wax, dissolve tube oil colors in a minimum of carbon tetrachloride and stir the dissolved color into the hot wax. If no carbon tetrachloride is at hand, dip out a spoonful of the hot wax, squeeze a little tube color into it, and stir and grind the wax and color together. Then place the spoon in the hot wax and stir in the color. Repeat the operation with one or more colors, testing out the color and transparency by dipping a piece of white paper and allowing it to cool.

For many purposes, oil and alcohol dyes are far superior to oil paint for coloring wax, as greater transparency may be obtained with dye than with oil color. If the exact color can not be secured with dyes, oil color may be added in combination to vary it.

By adding an equal quantity of paraffine to this formula, it is better adapted for wax casting, either moulds or casts, than clear wax or paraffine, the latter especially having a tendency to form bubbles when flowed upon a cold surface.

10. Wax for Tongues and Mouths of Mammals

Bleached beeswax	1 part
Paraffine wax	1 part

Melt together in the water bath. When dissolved, color as in Formula 9, using vermilion and Alizarin crimson tube oil colors.

For making artificial tongues, dip a fluff of absorbent cotton in the hot colored wax and after it ceases to drip, pin it so it hangs suspended from the edge of the table. When cool enough to handle, trim it with shears to the required size and model it into shape with the fingers and warm scraper, fitting it into the mouth of the artificial head and taking it out again until of the proper form and size to fit accurately between the teeth. It is sometimes a good plan, after the tongue is completed, to dip it quickly into the hot wax, thus smoothing the exterior and giving it a proper finish.

Fasten a wire to the rear end, dip the base into hot wax and set it in place in the mouth. With forceps and sable brush, kept warm in the hot wax, introduce warm pads of cotton saturated with wax underneath the tongue and paint over this with hot wax, thus

holding the tongue firmly in place. Paint the hot wax around the teeth to represent the gums, and join the lips with hot wax mixed with Vandyke brown, blending the two where they meet. The waxing around the teeth is perfected with a scraper, either cold or hot as the occasion requires, and may be smoothed by rubbing it with the side of a round needle set in a wooden handle, or by painting with turpentine and rubbing with the fingers. The papillae of the tongue may be imitated by digging it with the point of the scraper. Saliva is represented by painting with shellac and varnish.

C. Glue and Gelatine Compositions for Flexible Casts and Moulds

For casting objects in a composition that will remain flexible like rubber, the following is recommended:

Water and casting gelatine—melted together so as to form a good, rich mixture	1 gallon
Granulated sugar	1 pint
Gum camphor	1 ounce
Alcohol	2 ounces
Glycerine	1 quart

Place the cooked gelatine in a double boiler, add the sugar and glycerine and cook for a couple of hours, stirring occasionally. Add the camphor, previously dissolved in the alcohol. Color by the addition of water colors or dyes. A little Canada balsam gum or boiled linseed oil makes the composition more waterproof.

To cast from a dry plaster mould, shellac and dry, and oil slightly with linseed or salad oil. Allow the composition to cool a little so as to avoid steam bubbles, then pour it into the mould. Allow plenty of time—over night if necessary—for the composition to set and cool, then ease it from the mould. By reason of its flexibility, the cast will relieve from ordinary undercuts in the mould. Breakage or tearing of the cast is generally a sign that a poor quality of gelatine was used or that too much water was added to the composition.

For making flexible moulds, the casting gelatine regularly manufactured and sold for the use of ornamental plasterers for casting plaster wall and ceiling decorations is better than carpenters' glue, though for many purposes this will answer in place of the gelatine. The more water that is added to the glue or gelatine in making, the more flexible the mould and also the easier it tears in

removing the cast. A good rich mixture should therefore be used. For making a firmer mould, where the undercuts are slight, dry plaster may be stirred into the composition. If a glue mould is to be used for casting as soon as it is cool, no glycerine, sugar, nor camphor are required. But if it is desired to keep the mould for a time, mix into the hot glue the same or a smaller proportion of glycerine. This will keep indefinitely and may be remelted and used over and over again.

If hot wax or paraffine is to be cast from a glue or gelatine mould, when the composition—either with or without the addition of glycerine—has cooled a little and is ready for pouring, add about three tablespoonfuls of formalin to a pint of the composition. When no glycerine is used, the formalin acts very quickly and the glue must be stirred and poured before it thickens and becomes ropy. The more glycerine that is added to the glue or gelatine, the more time is allowed for stirring and pouring. Formaldehyde added to Formula 11 does not act so quickly and makes a fine firm mould.

In half an hour or so, the composition becomes set and firm, even though warm, when the object cast may be relieved from the glue mould. Without any wetting or oiling, hot wax and paraffine may be poured into the mould and when the wax is cool it relieves easily from the flexible mould. If the mould is cold, it may be heated before the hot wax is poured into it, in order to secure better definition. This is by far the best way to cast small, complicated objects like frogs and lizards, in wax or celluloid. The mould will not remelt when mixed with formaldehyde and also the sooner the requisite number of casts are made, the better, as the formaldehyde keeps acting on the glue or gelatine and makes it granular. For this reason the surface of the mould in a few days becomes so delicate that it is easily damaged in handling. Plaster may be cast from a glue-glycerine-formaldehyde mould by treating the surface in the same way as in an ordinary glue mould. Directions for this will be found in the chapter on Casting.

12. Papier-Mâché

Wood pulp, wet, with the excess of water squeezed out with the hands—by measure	10 ounces
Hot carpenters' glue of good strength	3 ounces
Plaster-of-Paris (casting plaster) dry	25 ounces
Flour paste containing a little whiting and boiled linseed oil, cooked together in a double boiler—by measure	3 ounces

A little white lead, added before the plaster, makes a more waterproof composition when dry. Mix the glue and paste with the wood pulp and stir and knead in the plaster until the mass has the consistency of dough. More or less plaster, water, or glue may be added, according to the consistency required. The flour and oil may be left out for some things, but they give a smoother modeling composition. Finely ground cork or fine sawdust may be substituted for half the plaster, making an excellent material for many purposes where lightness is essential.

Color as desired by mixing in dry color before or after the plaster is added. This composition becomes quite hard when dry. The addition of more glue makes it still harder, but if too much be added, the *mâché* will crack in drying.

White blotting paper torn into bits, put into hot water and crushed and refined by rubbing it between the open palms to work out the lumps and separate the fibers, makes good *mâché*. Builders' sheathing or lining paper, or ordinary newspaper, if boiled to dissolve the size, will also answer. But there is seldom any difficulty in getting good wood pulp, either in dry sheets or in bulk, from a paper mill or a dealer in taxidermy supplies.

If an electric motor is at hand, a good method of pulping and refining paper is to mush the paper in boiling water and then rig up a shaft with a paddle or propellor at the end which works in a bucket full of the mush, stirring the mass until it is sufficiently refined. It may then be poured on a wire mesh sieve to drain and is ready for use. Gum arabic, which takes almost constant stirring to dissolve, may be dissolved in the same way, if large quantities are required.

13. Papier-Mâché for Modeling Manikins

The same as Formula 12 but with dilute gum arabic substituted for the carpenters' glue, and a teaspoonful of Le Page's liquid glue or thin carpenters' glue added. This is better than Formula 12 for spreading on burlap to cover clay models of large mammals. Gum arabic does not greatly retard the setting of the plaster, but Le Page's glue is added to hold back the plaster for a few hours until the *mâché* can be placed. When set, the burlap holds its shape and does not pull and warp as burlap spread with hot glue

mâché sometimes does. Furthermore, gum arabic mâché, unless too much gum be added, will not soften by wetting when a wet long-haired skin is put on it. Unless well waterproofed, hot glue mâché will not stand wetting without softening and becoming mushy.

For modeling noses and legs of large mammals, this formula, by the addition of water and finely ground cork or mill dust, works nicely. When set, and before it dries out, it may be carved with a sharp knife as easily as a piece of soft pine. There is also no danger from cracking and checking when dry, as often happens with glue mâché.

14. Artificial Marble

For modeling where the effect of marble is desired rather than a plaster surface, magnesite is used. This is also much harder and tougher than plaster, and when poured upon a plate of clean glass and allowed to harden over night, it takes the high polished surface of the glass. It is used largely in the building trade for making artificial marble flooring, columns, etc. For making leaf moulds it is superior to plaster and will stand up under the press action, without deteriorating, much better than plaster moulds such as are generally used for making wax leaves.

Magnesite	4 pounds
Soapstone	1 pound
Fine white sand	1 pound

Wood pulp, squeezed dry—a handful—or asbestos fiber may be used instead of the wood pulp.

Magnesium chloride—according to the required consistency. (This is regularly sold diluted with water to the proper degree for use, which is about 20° test with an alkali tester.)

For translucency, to this is added about 2 parts of Epsom salts (Magnesium sulphate) dissolved in water, tested to register 15°.

Mix the liquids together, then stir in the wood pulp or asbestos fiber until of a jellylike consistency. Then add the magnesite, soapstone, and sand. Handle the same as plaster. This may be made thin for casting, or by the addition of more of the dry materials it may be made so as to model nicely.

Marble dust may be used instead of the sand, or both may be left out. For flooring, sawdust is used with asbestos and magnesite

give bulk. When hard it is polished with water, sand, and pumice stone; and when dry painted with linseed oil to fill the pores and waterproof it. Wax is also used. Artificial granite may be produced by mixing in coarse red and black sand or gravel. Crushed red bricks and coal will answer the same purpose. Imitation Italian marble is made by mixing water colors with small patches and pouring them on a horizontal plate of glass supported from below, with a mirror placed underneath. The colors are then streaked and blended with a brush, the mirror enabling the workman to arrange the colors as he may wish.

For permanent moulds, where something more durable than plaster is wanted, as for instance in permanent moulds for making pier-mâché deer heads, magnesite is superior to plaster. It may, of course, be reinforced with fiber or burlap the same as with plaster.

Magnesite, plaster, or other casts may be colored to imitate bronze by treating them as follows:

Paint the dry cast with raw umber, dry color, mixed with shellac, so it covers nicely. When dry, paint all over dark green with a thin oil color and turpentine. While wet, wipe off with a wad of cheese cloth damp with turpentine, and wipe again with a dry cheese cloth, leaving the green color in the depressions. While wet, blow on dry green water color (chrome green) mixed with dry plaster, using a powder atomizer. Wipe off lightly with a dry cheese cloth. Mix bronze powder (for sale at art stores) with thin shellac and, with a small dauber of cheese cloth and cotton, wipe and touch the high lights, being careful not to use too much. Imitation bronzes may thus be made so perfect as almost to match a real bronze.

To whiten and polish plaster or magnesite casts and render them smooth to the touch, paint the dry plaster with several coats of thin gum arabic and water, or soak the cast for an hour in the solution. When this is about half dry, stipple on dry soapstone. This when dry may be polished with a buffer. Painting over this, when dry, with white beeswax shaved and dissolved by stirring it in liquid celluloid; allowing this to become half dry, or "tacky," which will be in a few hours; and rubbing on dry soapstone with a wad of dry cheese cloth, gives a higher polish when buffed, and renders the cast waterproof.

15. Artificial Snow

A quick and easy method of building up a small snow scene where it is desired to represent fluffy, new-fallen snow, is as follows:

Construct the group, setting in the specimens and accessories complete. The specimens, or any objects that are not to be snow covered, are wrapped or tied up with tissue paper. The base and all the upper surfaces of large branches, etc., are covered with white cotton batting attached with hot paraffine and a brush, varying the depth of the cotton according to the depth of snow required.

Heat paraffine wax in a double boiler and when melted dip out a cupful and pour it into a tin pie plate or flat dish. With the left hand, dip the bristles of a hair brush (such as is used ordinarily to brush the hair) into the paraffine and with a large, dull knife in the right hand, strike the bristles firmly, thus "spattering" the paraffine, which leaves the brush in the form of warm flakes which bind fast to the object they strike. The sharpness of the stroke determines the distance to which the flakes will be projected and the hotter the wax the finer the flakes and the closer and firmer they stick. It is a good plan to hold the brush close to the object to be coated at first so as to insure a good grip, and later, cooler, coarser flakes may be thrown on from a greater distance.

To catch the drip, a tin cup is suspended under the end of the brush. To give glitter, when all completed sprinkle on a very little powdered glass frosting, to be procured of dealers in taxidermy supplies, or in large department stores. Very good imitation glass frosting may be made by flowing dilute gum arabic on a piece of slightly oiled glass. When dry, brush it off and break it up in a mortar or bowl.

Paraffine snow will not, of course, hold up in high temperatures or if the group be placed where the summer sun will shine through glass and thus concentrate the rays on the wax. Paraffine is made with high and low melting points. That with the highest melting point should be used. Stearic acid or Ceresin wax have a higher melting point and will answer equally well for snow scenes.

Another method of depositing the hot paraffine is by the use of the atomizer shown in Fig. 5. This works nicely, but the snow flakes are too small and fine and if one is not careful, he will imi-

tate frost rather than snow by the spraying method. The spray may be used first to good advantage because it takes much less time than spattering, and then be followed with the brush and spattering method for the final finish.

In making a large snow scene group of winter mule deer in the museum of the California Academy of Sciences, in San Francisco, the author invented and successfully used a circular bristle brush fasted to the end of a flexible shaft which was attached to an electric motor and geared down to the proper number of revolutions per minute. A can of hot paraffine was fastened over the revolving brush and through a small faucet at the bottom of the can, a small stream of wax poured down on the bristles. A drip cup was suspended below to catch any overflow from dropping upon finished work. A piece of flat iron was fastened to the frame and made adjustable to snap the bristles, as with the knife and hair brush in spattering. By keeping hot paraffine in the receptacle and turning on the motor, a steady stream of snow was produced, the flakes falling wherever directed and piling up rapidly. Paraffine snow is ideal material in which to represent animal tracks as it packs down like real snow by pressure.

Where the temperature is too high to admit of the use of paraffine, non-meltable materials must be used. Cotton batting glued on with plaster and flour paste, and when dry sprayed with white paint and Damar varnish, and dusted and sprinkled while wet with carbonate of magnesia powder, answers very well, but has not the realistic appearance of paraffine snow.

16. Artificial Ice

To build up large masses of ice, as for an iceberg, sheets of plate glass may be arranged in the desired form, and the joints soldered with tissue paper dipped in white shellac. Joints may also be made up with cotton and paraffine. Hot paraffine may be sprayed or flowed over the glass, and, with an electric heater, remelted as desired. This may be varnished with white Damar varnish. One or more plates of glass behind the first will give depth in transparent places, and the inner ones may be tinted with blue, green, or red to vary the color. Glass icicles may be purchased of dealers in taxidermy supplies. Fluffs of absorbent cotton dipped in clear

hot paraffine and varnished with white Damar varnish answer very well for icicles. Snow-ice may be readily made by stippling cooling paraffine upon the surfaces with a bristle brush.

17. Rock Work

Artificial rocks may be made in a variety of ways, either by modeling or casting, the latter producing the finest results. Small boulders may be cast by the use of a glue mould, or by piece moulds in plaster, directions for which will be found in the chapter on Casting.

Large rock masses and cliffs are best built up by the use of plaster moulds made from the natural rock. In making the moulds, do not select a difficult spot on the cliff and try to reproduce it by the use of glue or piece moulds. Select large flat or rounded areas, a yard square, containing good strong character or detail that will permit a "draw." Oil the rock with stearine and coal oil, thin, and flow on the liquid plaster. Stiffen this with layers of burlap dipped in liquid plaster, the size of the mould determining the number of layers of burlap required to stiffen and strengthen it. When set, with wooden wedges pry the mould off the rock, point up all bubble holes, and set it aside to dry. To make the cast, paint the surface with stearine and coal oil and flow with a thin coat of liquid plaster, backed up with a layer of burlap freshly dipped in a bucket of liquid plaster. When set, wedge off the cast, and set it aside to dry. As many casts as are required may thus be taken from one mould, and the moulds stored away for future use. Dry colors mixed with dilute gum arabic may be mixed in the plaster of which the rock casts are made, producing gray rock or whatever base color is desired. For outside work, rocks may thus be cast in cement.

The general shape of the rock mass is then built up with wooden uprights and cross braces, and the rock casts nailed and wired fast, cutting them with a saw and fitting them into any desired form. The joints are stuffed with paper, painted with water, and "pointed up" with plaster of the same color as the rock casts, using a modeling tool or trowel. In this way, any desired form of cliff may be easily built up, and overhangs or crevices worked out wherever desired, the rock character or modeling that would otherwise take

great skill and much time to model being done by process work or casting in a very short time. When dry, paint with oil colors and turpentine, and finish by stippling with dry colors and plaster. Granite effects may be produced by spattering on the color, using a sample of the natural rock as a model.

For a second quality of rock, where castings are not to be had, burlap and plaster may be used. In world's fairs and similar expositions, this is the material commonly used, but the usual mistake by this method lies in putting the plaster-saturated burlap over the wooden framework before the plaster sets, the wet burlap taking the general form of the wooden foundation and hanging in folds and wrinkles and looking like anything but rock. By dipping the burlap into thick liquid plaster mixed with wood pulp, laying it flat on a sanded floor, throwing on coarse sand and allowing the plaster to set, the large sheets may then be broken down and arranged over the framework in the same way as rock casts. Of course the definition and rock character are lacking by this method, but it is very much cheaper and for temporary exhibits will answer the purpose. Large rock masses may be painted by spraying on liquid oil or water colors with a gardener's spray pump, or other compressed air spraying machine, followed by dusting or blowing on dry colors. In the latter process the powder blower (Fig. 4) does good work, if made on a larger scale and used with compressed air. A constant stream of dry color may thus be directed against the rock and the coloring speedily accomplished.

Rocks for small groups may be made by dipping a piece of muslin into dilute gum arabic and throwing on fine sand. When half dry, this may be arranged over a wood, excelsior, or wire screen frame and when dry, painted as usual.

18. Fusible Metal for Casting Lizards and Other Small Objects

D'Arcet Metal—Fuses at 201° F.

Bismuth	2 parts
Tin	1 part
Lead	1 part

Heat over a gas stove and pour into a hot mould.

Rose's Metal—Fuses at 203° F., and contains a little more lead and less tin.

Wood's Metal—Fuses at 158° F.

Bismuth	50	parts
Lead	25	parts
Tin	12.5	parts
Cadmium	12.5	parts

This alloy liquefies at 158° F., and will dissolve in hot water. The practical joker's teaspoon is made of this or a similar alloy, so that when the guest stirs his cup of hot coffee or tea, to his astonishment his spoon begins to melt. The substitution of mercury, or quicksilver, for cadmium gives a low melting point, but makes the alloy more brittle. Low-fusing alloys are used for safety fire sprinklers, boiler plugs, etc. A variety of small ornaments for use as paper weights, etc., are also made of these alloys.

19. Solution for Preserving the Skins of Fish, Snakes, etc.

Water	1	part
Glycerine	1	part

Carpenters' glue, thin and warm, added until when cooled to the temperature of the room the solution does not jellyfy.

This is for immersing the skins of fish and snakes preparatory to mounting them. It renders the fins and skins permanently flexible and transparent. Full directions for its use will be found in the chapter on Fish and Reptiles.

CHAPTER III

CASTING

Making a mould of an object and duplicating the object in some other material is known as "casting." Casting thus takes the same position in the field of art as photography, in that the object or picture is duplicated by process work instead of by direct modeling or painting.

If the end of the finger be pushed into soft clay and withdrawn, the hole in the clay represents the "mould." If plaster, or any other material that hardens, be poured into the hole and allowed to become hard and the clay removed, this duplicate of the original object is called the "cast."

Moulds and casts are made in a variety of plastic materials, these varying with the object to be cast, and the material of which the duplicate finished product is to be made. The material of which a mould is made and the manner of making it is also determined in some instances by the number of copies that are required, whether one or more.

Moulds and casts are usually made of plaster-of-Paris of a grade known as "casting plaster." Dental plaster is a fine grade of casting plaster and is the best procurable. Other grades are made for plastering walls and ceilings, but they are made to set slowly and are not ordinarily used in casting.

Casting plaster of good quality, when mixed with water to the consistency of cream, soon "sets," or becomes hard. Either common salt or potassium sulphate, dissolved in the water in which plaster is mixed, will make the batch set more rapidly, but it also makes the plaster more brittle after it has dried out. Plaster will set more quickly with hot, not boiling, water than with cold. Hot salt water is sometimes used for a quick mould, or hot water in which potassium sulphate is dissolved. A tablespoonful of dextrine dissolved in half a gallon of water with which plaster is mixed,

makes the finished, dried cast harder than clear plaster. Gum arabic dissolved in water also makes the plaster very hard when dried out, and boiling a dry cast in borax water or paraffine hardens and smooths it. A little acetic acid added to water in which plaster is mixed will retard the setting. Le Page's liquid glue, or thin, warm, carpenters' glue, mixed in the water also holds back the batch from setting. Le Page's glue is the most convenient to use, as by dipping the finger into the glue and washing it off and distributing it in a half gallon of water in which plaster is mixed, the plaster will remain soft for a couple of hours. More glue will hold it back longer and if a quantity be put in, as in making papier-mâché, the plaster never sets, but becomes hard only by drying and may be softened again by soaking in water and heating.

If a batch of mixed plaster begins to set before it can be gotten into place, do not try to hold it back and save the batch by stirring in more water to thin it down. This "kills" the plaster and if sufficient water be added it never will set. If a batch of plaster that is intended for casting begins to set and becomes too hard before it can be properly placed, throw it out and mix another batch. Experience alone will tell the exact amount that should be mixed at any one time, without waste. In mixing a batch of plaster, put the required quantity of water in a bowl or other vessel, and sift in the dry plaster until it rises in a cone or pyramid above the water and remains dry for a few moments. Then mix it well with the hand or a spoon, working out all the lumps. The mixture for ordinary work should have the consistency of cream. If too thin, water bubbles will form and when these dry out, it leaves the cast pitted and porous, and therefore weak. It is better to mix plaster too thick and then reduce it by the addition of water, rather than have the mixture too thin and try to thicken it by stirring in more dry plaster, as the latter produces lumps and an uneven mixture. It is sometimes an advantage to allow plaster to begin to set before applying it to upright surfaces, provided time enough be allowed to place it, as the setting plaster does not run down so readily. Dry water colors may be mixed with gum arabic water and added, or some colors may be simply stirred in the water in which plaster is mixed, thus producing a colored mould or cast.

If liquid plaster is to be poured upon a hard plaster surface and it is desired that the two separate again when set, the surface of

the hard plaster, or mould, whether wet or dry, is best painted with warm stearic acid (commonly called stearine) dissolved by heating it with coal oil, or kerosene, in a water bath. Or the hard surface, wet or dry, may be shellacked and when dry oiled with salad or sperm oil, or lard. This keeps the plaster from uniting and makes a "parting."

If it is desired to add fresh plaster to a batch that has set or dried and have them unite, wet the dry plaster surface thoroughly then add very thin plaster at first and thicker plaster over this. In filling bubble holes and in "pointing up," or correcting details, hard plaster should always be thoroughly saturated with water before adding fresh plaster, or the water from the freshly applied mixture will be absorbed and leave it chalky and soft. In adding small quantities of fresh plaster, it is a good plan to sift the dry plaster into the water and use the submerged plaster without stirring by dipping it out with a modeling tool or spoon and adding it to the surface to be built up.

Before an object is cast, it must be carefully studied to decide upon the method which is best to use. If the object be firm and hard and without undercuts, like an orange cut in half and laid flat side down on the table, it is necessary only to oil the half orange slightly, lay it on a piece of oiled paper and pour liquid plaster over it. When the plaster is set, the half orange is taken out of the mould. By oiling the inside of the wet or dry mould with stearine and kerosene, fresh plaster may be poured in and when set, taken out again, thus producing in plaster a duplicate of the half orange.

But if the whole orange is to be cast, the mould must be made in even halves in order to get the orange out of the mould. This is called a "piece mould," and objects may be cast with any number of pieces, these being determined by the undercuts on the surface to be cast. Sometimes in making complicated piece moulds of large objects, sections made up of a number of small pieces are covered with a plaster "jacket," or outside shell, into which all the small pieces nest. The jackets are tied together in assembling the mould. In taking off the mould, the jackets are first removed, and then one piece after the other of the piece mould.

If the object be flexible so it will relieve from the undercuts of a hard mould, as for instance a snake laid flat upon a smooth rock

surface, the object, after the plaster mould is set, will relieve from the undercuts and come out whole, owing to its flexibility. To reproduce the snake in plaster, it is necessary only to grease the mould, pour in plaster and allow it to harden. The plaster cast is now locked in the mould and the only way to relieve it is to chip or break away the mould with chisel and mallet until it is entirely removed and the cast freed. This is what is termed a "waste mould" and is capable of producing but one copy or duplicate.

If more than one cast is desired from such a mould, the copies, in order to relieve from the mould, must be made in a flexible material, like gelatine composition, Formula 11.

Another method of making a waste mould of a flexible object like a snake or a lizard posed on a rock, is by the use of the paraffine mould. Instead of plaster, hot paraffine is poured over the wet snake and rock, and then thickened by painting on cooling paraffine until heavy enough to make a firm mould when cold. A plaster jacket is sometimes used over large paraffine moulds to stiffen them. When cold—a state which may be hastened by placing the whole under a faucet of running water—the snake or lizard is relieved from the wax mould. Plaster is poured into the mould and rocked about and reinforced with tow saturated with liquid plaster. When set, the mould is laid on a piece of wire screen, suspended over a gas stove, and as the wax softens it is torn off the plaster cast in strips. This is better than putting the whole into a pan in the oven and melting off or liquefying the wax mould.

When the object is firm and full of undercuts, like a rough boulder, the glue or gelatine mould must be used (Formula 11). Here we have a flexible mould which will relieve from reasonable undercuts, and hard casts may be turned out of this mould in various materials, such as plaster, magnesite, or celluloid; or wax, fusible metal, or flexible casts may be made by hardening the gelatine mould by the admixture of formaldehyde so it will not melt when a hot material is poured into it.

The making of bronze casts is a difficult and expensive process and will not be described; since for ordinary museum purposes, lizards and other small objects may be easily and accurately cast by other less expensive methods and when colored to imitate bronzes, as in Formula 14, they answer every purpose.

Casting with a Piece Mould.—For an illustration of this method of casting, we will select a small, smooth boulder and proceed to make a duplicate of it in plaster. Some fine sand is procured and wet just enough so it will model well with a spatula or putty knife. The boulder is studied to see where the largest “draw,” or section free from undercuts, may be made, and this area is left uppermost. The sand is piled around the stone and leveled off until just the precise surface of the stone that will draw is left exposed. With a small brush, the exposed surface of the stone is oiled with warm stearine mixture.

Plaster is mixed with the proper quantity of water and poured on the stone and blown hard with the breath in order to force the liquid plaster into all the depressions and destroy air bubbles. The plaster is allowed to harden a little and is then reinforced with squares of wet burlap submerged and soused in liquid plaster. Two or more layers of burlap and plaster may be given, according to the size of the boulder. The advantage of burlap is, that should the mould crack in removing it, the plaster remains hinged by the burlap and is easily strengthened by adding fresh plaster and burlap to the back of the mould, over the crack. When the plaster has become warm, which is a sign that it has set, roll the stone over and brush off the sand. With a knife, cut and smooth the edge of the plaster and drill shallow holes, or cut nicks in it, to act as “keys” for the adjoining piece.

A lump of clay is rolled out on the table with a round bottle used as a rolling pin, and a long strip about an inch wide cut off. The next largest section of the stone is decided upon and the strip of clay, or “wall” as it is called, modeled standing on edge across the stone, cutting the exposed surface in two and taking in only the area desired for casting the second piece, which must also be free from undercuts.

The edges of the first piece, the inside of the clay wall and the section to be covered, are oiled, and covered with plaster as before. When set, the clay wall is removed, the edges of the second piece trimmed, keyed, and oiled, and plaster poured in and backed up with burlap and plaster, forming the third or last section of a three-piece mould of the boulder. The whole is allowed to set and harden a few hours. The overlapping seams are trimmed down level with a knife so as to expose the seams or joints, and

the mould tapped all over with a wooden mallet to loosen it. A small chisel and small wooden wedges driven into the seams are used to pry the sections apart, and the mould is lifted off. After dusting out the inside and pointing up the edges and bubble holes, the mould may be allowed to dry out, or it may be used for a cast at once.

In either case, paint the inside all over with warm stearine mixture and fasten the two largest pieces of the mould together by plastering over the outside seams with "plasteline" composition or clay. There are two methods of putting in the plaster, both of which will be given.

Pour in liquid plaster, set the third piece in place, wrap the whole with twine, plaster over the remaining seams with clay, and rock the mould slowly about in all directions, thus distributing the plaster evenly all over the inside, layer upon layer. Allow plenty of time for rocking or the liquid plaster will settle at the low side and leave the upper parts thin and weak when the rocking is stopped and the mould is set aside. This sometimes happens and in order to avoid it and also to make a stronger cast, pour some liquid plaster into the open and partly assembled mould and rock it about, throwing out the excess and coating the inside of the loose piece with it, wiping off the edges perfectly clean. When this has hardened a little, reinforce the inside and the loose piece with burlap and plaster. When partly set, pour some liquid plaster inside, set the loose piece in place and rock and roll as before, allowing the mould finally to rest upon the end which was open. This insures an evenly coated and reinforced cast, and is the safest method to use. Of course, if weight is not objectionable, in some instances a mould may be filled solid by boring a hole in what is to be the under side of the cast and pouring it full of liquid plaster. A hollow cast may also be made by pouring the plaster or other materials through a hole and rocking to distribute it.

After tapping the mould to loosen it from the cast, a chisel and wedges are used and the cast taken out. The ridges formed by the mould seams are worked off with a scraper and all bubble holes and imperfections pointed up, when the cast is set aside to dry. As many copies as desired may be cast from a piece mould. When dry, the plaster boulder is painted like the original by spattering on oil colors with a hair brush, using a knife blade to snap

the bristles and throw the paint. A tooth brush may be used the same way for small stones, and a power spray where many are to be colored. Piece moulds of more complicated objects are done in the same general way, the rule being to cast as large a surface as will draw without locking the undercuts.

A quicker way than that just described, of casting so simple an object as a smooth boulder, and which was given to demonstrate the means of making piece moulds generally, is to do away with the sand and clay walls entirely, as follows: Oil the stone all over. Lay a piece of strong thread on a piece of oiled paper and another thread crossing the first at a right angle, near one end. Drive a few nails into the board upon which the paper lies, snip off the heads and balance the boulder upon them. Flow the stone all over with plaster and draw the threads up loosely around the stone, making them touch the latter all around by the use of a small brush. Add thicker plaster all over and just before it hardens, pull on the threads at an angle to the stone all around, the threads cutting the mould into four pieces. Threads may thus be arranged to cut a mould into two, three, or more pieces and may be made to cut at any angle or curve desired. The mould may be strengthened with burlap or fiber mixed with the plaster, being careful not to cover the joints. Fresh plaster may be put on over the joints by tucking wet thread into the grooves which were made by withdrawing the former threads, adding more fresh plaster, and cutting through this as before. When set, the pieces of the mould are wedged apart as usual. Thin wire is also used, in place of thread, for cutting moulds, but the latter, being flexible, hugs the wet plaster surface and is easily adjusted with an artist's brush.

This method of dividing moulds is a great time saver but is not adapted to the finest work on small objects, as the seams or joints are apt to be wider than by the clay-wall process. Strips of tin, thin cardboard, or stiff paper dipped in warm stearine solution and pushed into soft clay models, are sometimes used to define areas in casting, in the same way as strips of clay. Cement or concrete for outside use is cast from plaster moulds in the same way as plaster, but cement requires more time to set, and also requires small holes in the bottom of the mould for a water outlet for seepage.

To make a plaster mould of an object where it is not desired

to oil or grease the object in the ordinary way, dip or paint the object with a rather thick solution of gum arabic in water. Let the gum dry. Pour on plaster and allow it to remain an hour or two to liquefy the gum arabic, and the plaster may be readily lifted off. Very fine detail may be gotten in this way. A rock or boulder may be sharply cast by the use of gum arabic instead of oil and grease.

Casting with a Waste Mould.—Where but a single plaster copy of an undercut flexible object is wanted, the waste mould is used, the flexible object relieving from the firm mould. For an illustration of this method, we will select the nose of a dead prong buck, a copy of which is needed to serve as a guide in modeling.

The head is posed so the nose stands straight up. If the mouth has a tendency to open, a pin is driven in between the lower front teeth into the gums of the upper jaw. The lips and nostrils are arranged naturally, and the portion to be cast painted with stearine, kerosene, and powdered clay, to hold the hair down when smoothed with the fingers, so it won't pull out in the plaster mould. In default of stearine, hot tallow or lard, or clay mixed with water and oil will answer. Excelsior, grass, or sand is arranged around the face and covered with a piece of oiled paper with a hole cut in it through which the nose protrudes, thus exposing above the paper only the portion to be cast.

Plaster is poured over the nose and modeled on half an inch thick all over. When set, the mould is eased off the flexible nose and draws easily. If the insides of the nostrils should break off, they may be fastened in place in the mould with thick shellac, painted on both surfaces and united; or they may be stuck in place with a little plasteline or clay.

The mould is then oiled with stearine and coal oil, or if this is not at hand, it may be shellacked and dried, and then oiled with lard, sperm, or any machine oil. The mould is then poured full of liquid plaster, inserting the ends of a wire loop by which to hang the cast on the wall when finished. When set, the mould, or outer shell, is broken and chipped away with chisel and mallet, exposing the cast, which is a counterpart of the nose of the dead antelope. Casts of noses or other parts of dead animals are valuable aids in mounting and an opportunity to make them should never be lost.

In making waste moulds, in order to know just how deep to chisel without cutting and nicking the cast, the usual practice is

to make the waste mould in two colors. First put on a thin layer of plaster containing a little dry burnt sienna stirred in the water, which makes a pink-colored plaster. When this has set, paint it over with thin clay water, then make the next coat or layer of clear plaster to the required thickness. Never reinforce a waste mould with fiber or burlap, as it is difficult to break away, unless it be put on a smooth surface that has been painted with clay water so the whole slab will wedge off in one piece. In cutting away the waste mould of two colors, the white outer layer is first removed, and by reason of the painting of clay water, this comes away easily from the colored plaster. As much care as is desired may then be used in removing the thin stratum of colored plaster overlying the white cast. The colors of course may be reversed and the cast itself colored.

Chipping or breaking away a waste mould requires considerable skill to avoid nicking and disfiguring the cast. When hard plaster is used in the first layer, it is sometimes almost impossible to relieve a delicate cast without cracking or shattering it by the blows of the mallet or hammer, even though it be not actually cut into with the chisel. To avoid this, the plaster composing the first or both layers of the mould should be mixed with a proportion of "killed" plaster, which renders the mould soft and easily crumbled and broken away, according to the quantity added. By this means, very delicate objects may be cast in plaster waste moulds, the latter being broken away with a scalpel point or even washed off in water if sufficient killed plaster be added. "Killed" plaster is made by mixing a batch of plaster in the ordinary way and when it begins to set, adding and stirring in more water. This is repeated until no signs of setting exist. When dry, such plaster is soft and chalky. A proportion of killed plaster mixed in with a batch of fresh plaster weakens the batch when set. When mixed, this sets very quickly and a little glue water must be added to hold it back until it can be placed. If enough killed plaster be added to a fresh batch, the latter when set is water-soluble and may be dissolved by placing it in water and crushing it.

The breaking away of a waste mould is the laborious part of the operation of waste mould casting; but when the plaster is softened as directed, much time and labor are saved and the result is much more satisfactory.

For making waste moulds, to produce a mould that will break away and crumble easily, instead of mixing wet killed plaster with fresh plaster, the killed plaster may be made ahead of time, spread out and dried and then ground to a powder. This may be kept on hand as stock and mixed with fresh dry plaster in any proportion. About half and half is good for ordinary work. Wetting the mould just before chiseling or breaking it off softens the plaster more and makes it easier to remove from the cast.

If a harder, firmer, waste mould of killed plaster is desired, mix in a good proportion of gum arabic, syrupy in consistency. When dry, the gum hardens the mould. Without any oiling, flow the plaster for making the cast directly on the dry mould surface. When set, place in water. The gum softens and the killed plaster mould will break away easily, giving a clean, sharp impression.

The surface of ordinary plaster may be painted a few times with gum arabic and allowed to dry. Without oiling, pour plaster in the mould. When set, place in water. The gum liquefies, and relieves the cast, which will come out very clean and sharp.

Casting Bones with a Clay Mould, to Make Duplicates to Be Used in Mounting Large Mammals.—It often happens that the skin and skeleton of the same animal are wanted for separate exhibits. In such cases a clay model may be made, using the natural bones to model over, and then a manikin made by the casting process as described in the chapter on Mounting Large Mammals, after which the bones may be used for any desired purpose. But if it is not desired to use the casting process of mounting, the bones themselves, or faithful duplicates, will be necessary.

Duplicate bones are sometimes carved out of wood, using the natural bones as models. To secure accurate duplicates by wood carving means hard work, and the clay mould is recommended to take its place. To make a glue or plaster mould of each bone would be taking unnecessary trouble.

Modeling clay is placed in a tub or bucket and pounded and punched with a short length of pipe or piece of scantling, water being added until the mass is of the consistency of putty. The lumps may be broken up by forcing the clay through the meshes of a sieve of quarter-inch wire netting, using an old plane iron fastened to the end of a stick of wood. The sieve is placed over an empty bucket and some of the wet clay put into it. The

preparator sits on a box level with the sieve, and with the butt end of the stick resting on the shoulder, the clay is worked and forced with the plane iron through the meshes of the sieve, falling into the bucket below in the form of long noodles. While in this condition, linseed oil is added and the clay is kneaded and pounded, until the oil is thoroughly incorporated and the mass no longer adheres to objects pressed into it.

A solid bed of the oiled clay, longer, wider, and deeper than the bone to be cast, is built up on the table. A stout wire loop is twisted around each end of the bone, and the latter, after being immersed in water, is forced, front side down, into the clay bed, nearly submerging it. The clay is pressed around the upper edges so it fits the bone snugly, then by the aid of small sticks placed in the wire loops, the bone is slowly drawn out of the clay. Any cracks may be closed by pressing the clay back into place, and the result is a rough mould of the bone. The latter may be readily cleaned by immersing and scrubbing it in water and carbon tetrachloride to remove the clay and oil.

A stick of pine wood is cut an inch or so shorter and somewhat more slender than the inside of the mould. This is placed in hot paraffine fifteen minutes to keep it from swelling by moisture. The inside of the mould is lined with plaster, gum arabic water, and tow, mixed together, the stick inserted, and the mould filled with more of the plaster composition. When the plaster is set, the clay is pulled away and the resulting cast, though not an absolute replica, is accurate enough to be used for modeling a manikin, and much more so than bones carved from wood in the usual way.

Glue and Gelatine Mould Casting.—When the object to be cast is hard and immovable and full of undercuts, like a deeply-pitted boulder, and a number of copies are desired, the flexible glue mould is used. This type of mould is also useful in casting fish, snakes, lizards and other reptiles. However, these must be carefully dried and oiled—sometimes shellacked first—before the composition is poured on, for any moisture coming from the object unites with the glue, keeps it soft at that point, and causes it to tear loose when the mould is taken off, and adhere to the object.

For casting a simple object like a chloroformed, dead lizard posed on a rock, the under side of which is to be open in the mould, all that is necessary is to pose the lizard and glue it to the stone

with thick shellac. When dry, set the stone on a piece of board and model around the base with plasteline to the desired height to kill the undercut of the stone, allowing the circular clay bed to extend about an inch all around with a perpendicular edge. Shellac the clay and, when dry, oil the clay, stone, and lizard with linseed or salad oil. Cut a strip of cardboard a couple of inches wider than the height of the lizard's head and long enough to reach around the clay bed and overlap an inch or so. Adjust it around the clay, mark it with a pencil, take it off again and sew the overlapping ends of the cardboard with needle and thread. Set the circle of cardboard over the clay bed and drive a few pins through the cardboard into the base board to keep the former from floating and moving when the hot glue is poured in. Stop the seams with plasteline to prevent leakage and pour the warm glue over the lizard, filling the cardboard jacket full enough so that the head is covered by an inch of the liquid. While this is soft, cut out a piece of cardboard to fit inside and drop it in, allowing it to lie flat and adhere to the glue to stiffen the mould. The mould may be further stiffened by painting the outside of the cardboard with hot paraffine and crusting it over with plaster.

In casting an object like a round stone, the stone may be supported on a few nails driven into the board and the heads snipped off so they will afterwards draw out of the glue mould. The cardboard jacket is adjusted as usual and the interior poured full of the composition. To get the stone out, the cardboard and glue are cut through to the stone on three sides, the fourth acting as a hinge and opening like an oyster.

It will be seen that the cardboard, for casting small objects, takes the place of the plaster shell or jacket which is used for larger objects as described in the following process. As an illustration, we will select a good-sized plaster bust of a person, several copies of which are desired.

The model or bust is covered with several layers of damp tissue paper and wrapped with thread to hold it in place. This is to keep the model clean. Clay of the consistency of soft putty is rolled out on the table with a round bottle or a rolling pin until about half an inch in thickness all over; or in place of this, a square chunk may be sliced like bread, and the slices cut into proper sizes for handling. The tissue paper over the model is covered evenly with

the clay, which is cut and fitted together by smoothing with the fingers and modeling tools, until the model is covered evenly to the depth of half an inch or more. All undercuts are relieved by the addition of more clay, which is smoothed by rubbing with the fingers wet with water.

As the glue mould must have a plaster jacket, or shell, to hold it rigid, this is first made. A cardboard jacket would require the use of too much glue and is not practicable. The jacket is made in two even halves. In order to divide it thus, long strips of clay an inch or more in width are modeled on to act as a wall, beginning at the bottom and going over the top and down the other side. To act as keys to adjust the moulds, several V-shaped ridges extending crosswise of the strips are modeled on the clay walls on the side which is first to receive the plaster coating. After being oiled with stearine and coal oil, it is ready for the plaster. Allow a little time for this to start setting before applying it, as this helps to stop the plaster from running when it is applied to a perpendicular surface. Put it on thinly at first, then, as it thickens, model it on so the plaster is an inch or so in thickness all over, the thickness depending upon the size of the model, the larger the mass the heavier the mould. When firm enough, the plaster is reinforced with squares of burlap dipped and saturated with plaster. When this has set, the clay wall is removed, the plaster edge oiled, and the other half covered in the same way. When plenty of time has been allowed for the plaster to harden, turn the whole thing upside down, key and oil the edges of the plaster, but not the base of the bust itself, and cover with plaster and burlap as before. When set, with a knife cut off the joint ridges and with a narrow chisel and a few small wooden wedges, pry apart the upper halves and remove them from the clay-covered model and brush out the inside carefully. Remove the clay and tissue paper from the model, leaving the latter clean and standing upright attached to the third or base piece of the mould. Bore a few holes in the sides of the plaster jacket at different heights all around to allow for the escape of air when the hot glue is poured in, and cut a large funnel-shaped hole at the top through which to pour.

Shellac the model and base and the insides of the jacket, and, when dry, oil with salad or olive oil. Shellac will dry on a wet plaster surface. Without shellacking and oiling, the glue, when

chilled, would stick fast to the wet plaster mould and be torn in pieces before it would free. A glue mould may be made of a wet clay object by first shellacking and then oiling it when the shellac is dry. Assemble the mould and tie it together with stout string. In the meantime, heat the casting gelatine in a double boiler. When all dissolved and free from lumps, allow the gelatine to cool somewhat, stirring meanwhile to facilitate cooling and to prevent a scum from forming on the surface. Roll up a clay funnel and model it in place over the hole in the top, and pour in the warm gelatine, pouring slowly to avoid making air and steam bubbles. As the liquid rises and reaches the holes in the jacket, plug them with clay and fill the mould full.

Allow several hours, or overnight, for the gelatine to cool, then pry the upper shells apart with a small chisel and lift off one half, leaving the other in place. With a sharp-pointed knife, using the edge of the plaster shell as a guide, cut through the rubbery gelatine mould all around until it is cut in two pieces. Remove the front or exposed half of the gelatine mould and lay it into the jacket that it came out of. Lift off the other half from the base, leaving the gelatine mould in place to preserve its shape, and allow both to remain exposed to the air for an hour or two to dry out.

If liquid plaster be poured directly into a glue or gelatine mould, the moisture, and heating of the plaster while setting, melts the surface of the glue and combines with it, thereby retarding the setting of the plaster surface; and as a result this is lost and the sharpness and fine definition of the cast is left sticking to the surface of the mould. In order to correct this, the surface of the glue mould is treated as follows: Brush over the entire inner or casting surface with dry soapstone to remove the remaining moisture and oil. With a soft brush, clean out the soapstone and flow or paint the interior with a saturated solution of alum (aluminum sulphate, commonly called "alum"), made by dissolving a quarter of a pint of alum in a pint of boiling water and allowing it to settle and cool and then draining off the liquid and straining it through cheese cloth. Dry off the surface by pressing it and absorbing the water with a wad of dry cheese cloth. Oil all over thinly with stearine and kerosene, thinned down with plenty of the latter so it will not leave a heavy deposit and destroy detail in the cast.

The two upper pieces of the mould with the glue lining in posi-

tion are tied together with string, leaving out the third or base piece. The bottom now being open, liquid plaster is poured in and distributed. When this has hardened sufficiently so that it is not liable to damage, the interior is lined up and reinforced with squares of burlap and plaster. Strike off the base so the cast will be level. When the cast is set, the cord is untied and the plaster jackets removed. The gelatine lining is now taken off, relieving the undercuts nicely and freeing the cast.

A number of casts may thus be taken from a glue mould, by oiling the mould each time before pouring in the liquid; but after a number of casts have been taken, the surface of the glue mould deteriorates and loses its sharpness, and a new one must be made, using the same plaster jacket. When not in use, the glue moulds are kept in their respective jackets, placed on the model which is still attached to the base, and tied with a string. This keeps the moulds from drying out and holds them in place. If a glue or gelatine mould is to be kept for any great length of time, gelatine composition (Formula 11) should be used, instead of clear gelatine.

Celluloid casts may be made from glue-glycerine moulds, and it is sometimes best to add a proportion of dry plaster and soapstone to the glue to give firmness, if the undercuts are slight. For celluloid casts, the inside of the glue mould is simply dried out, not oiled, and clear or colored liquid celluloid (Formula 8) is painted or flowed in, one coat over the other. A day or so should be allowed between coats for drying. After a few coats have thus been put on, subsequent coats may be dusted, while fresh, with dry flock or mill dust, and again painted with the liquid. Sheet cotton, split, and the excess of fluffy cotton brushed off, makes excellent reinforcement for celluloid casts. Lay in the dry cotton in strips, and paint over with the liquid, which is absorbed at once. When dry, the celluloid cast is shellacked inside, dried, flowed with hot wax and reinforced with cotton painted or dipped in wax. This may be further reinforced with plaster and tow or burlap on large casts.

In casting fish and other objects in celluloid, they may sometimes be cast in clear celluloid, and colored from the inside with oil colors, then reinforced with wax and cotton. But one celluloid cast can be taken from a glue mould, as the celluloid will not relieve. The mould is melted off the cast by heating with dry heat, to save

the bulk of the composition, and then finished and cleaned by immersion in water just warm enough to melt the glue.

By adding formaldehyde to the glue composition, without oiling, wax may be flowed, hot, into the heated mould and finer definition obtained in the wax cast than by any other method known to the author. When cold, the wax cast relieves perfectly from the mould and by careful handling a number of sharp wax casts may be taken from one mould. This is much superior to the old method of making plaster moulds and soaking them in hot water to make the wax cast relieve. More or less of the plaster surface is always left on the cast and the mould therefore soon loses its sharpness.

Piece moulds may be made in glue-formalin composition, as with plaster, by allowing the composition to set and oiling it before pouring on fresh hot material. Flexible casts may also be made from these moulds.

Fusible metals (Formula 18) will cast clean and sharp from a glue-formalin mould by flowing or painting the inside with formalin so as to harden the surface evenly. The mould should be warmed before pouring in the metal. Before the latter gets hard, a block of wood may be pushed into it and later removed, to give lightness to the cast and also to save metal; or before it gets cold, some may be scooped out with a spoon. Too hot metal should not be used and metal with a low fusing point should be selected, as very hot metal will pit the mould and produce a granular surface on the cast. Fusible metal is adapted to the reproduction of small objects only, as the high cost of materials makes the metal too expensive to use on a large scale.

Casting in Paper.—The principle of paper casting is very simple and consists in tearing off pieces of soft, damp paper, coating them with some form of paste and pasting them inside of a mould, one layer on top of the other, until a sufficient thickness is attained to secure the proper degree of strength and rigidity when dry. This method necessitates an open mould in order that the fingers may reach every part of the interior to place and force the paper into position. An open waste mould may be used, but generally the paper process is used with plaster piece moulds, and the sections of the cast joined after they are taken out when dry. Or the edges may be trimmed to conform to the edges of the mould, put back again and the mould assembled, with the exception

in some cases of one piece, to allow the hand to reach all parts of the interior, when the joints are pasted over with fresh material and the whole allowed to dry in the mould. The cast is then taken out and the seams pointed up and perfected.

Paper casts are largely used where extreme lightness is desired for large objects, and the methods of procedure vary according to the detail or definition in the mould, as follows: The dry plaster half mould is greased all over with stearine and coal oil, warmed together in a double boiler. When dry, this is painted over with flour paste, and pieces of torn—not cut—damp paper painted with paste, are placed in the mould, and rubbed in with the fingers and beaten with a stiff brush to send the paper into all the crevices and details of the mould. Two or more colors of paper may be used, first one and then the other, so it may be easily seen when the mould is evenly covered all over with each alternate layer and the thickness of the cast equalized.

The size of the mould and the amount of detail in it will determine the thickness, or number of layers that will be required and also the weight and quality of paper to be used. This will vary from fine tissue paper to heavy builders' paper. When a mould is large and without detail, a paper of the weight and texture of ordinary newspaper may be used for the first layer. After this is pasted in, brushed with paste and rubbed and beaten in, a second coat of the same or a heavier paper may be used, followed by the number required to secure strength. For large casts, as many as ten layers are sometimes given. In making paper casts, plenty of time should be given for the paper to become bone dry in the mould. If taken out too quickly the first layer will stick to the mould in places and tear off in ribbons, thus causing a loss of detail in the finished cast. When dry, the cast is eased out of the mould, the edges trimmed, braces put in if necessary, and the two half casts tied together and paper or cheese cloth pasted over the joints, either inside or outside as the case may be.

Models of large fish, cetaceans, etc., which are suspended from the ceilings of exhibition halls, and in which lightness is necessary, are generally made in this way, the cast being painted in imitation of the real object. In some museums, such casts are used to represent whales, only one half of the model being shown. This, being hollow, houses the skeleton, so that the exterior of the whale may

be seen from one side and the skeleton in position from the other side.

When more detail is desired, as for instance in making a paper boulder or rock from a plaster mould which is full of fine modeling, after painting with the oil and a light brushing over with paste, tear thin dry tissue paper into pieces and beat them into the mould, one at a time, with a stiff paint brush. Paint this layer with paste and again beat and stipple it so as to press the paper into every line and crevice of the mould. Any bridging of depressions means a loss of detail in the finished cast. It is better to paint the mould with paste and lay in torn pieces of dry tissue paper, rather than try to paint the paste on the paper, as the wet tissue paper is too flimsy to handle and sticks to the fingers. Paper of the weight of newspaper may be painted with paste and handled easily. Sometimes a little hot glue or gum arabic is mixed with the flour paste to give it more body. Too much of either, however, should not be used, as they tend to produce shrinkage and warpage in the cast when drying. Dry whiting added to flour paste while cooking gives it more strength and makes a smooth working paste. Dextrine, either white or yellow, mixed with cold water, works as well as flour paste and has the additional advantage of not souring nor becoming mouldy, as sometimes happens with flour paste casts in damp weather. Boric acid added to flour paste while cooking will help to prevent mould. Silicate of soda, used instead of flour paste, gives a translucent cast; if used with tissue paper, either plain or dyed, works well and dries quickly.

After the first layer of tissue paper has been well beaten into the mould, allow it to dry a little, cover the surface with fine, dry sawdust or cork dust, and with the fingers and fist, press and tamp the sawdust, thus forcing the paper into every depression. Throw out the sawdust, brush out the loose particles, paint it over with paste and lay on the balance of the paper required to finish the cast. Some of the sawdust will remain in the depressions, thus filling the pockets and insuring better definition in the cast.

To stop warpage in paper casts, they may be flowed with a thin layer of plaster and gum arabic, which may be left until dry and then be broken out, or if the additional weight on small casts is not objectionable, it may be left in. The dry sawdust method gives extreme lightness and enough flexibility to permit a

cast to be taken out of a slightly undercut mould. If there are no undercuts, to send the first layer of tissue paper into every depression of the mould, spread a piece of newspaper with soft papier-mâché, tear the paper into pieces as desired, and lay them into the mould, mâché side down. Paint flour paste on the paper when it is in place, or dip the fingers in the paste, and by rubbing over the paper, drive the mâché into every line and depression. This may be backed up with heavier paper, cheese cloth, or burlap spread with mâché and cut into squares.

Spreading paper or cloth with mâché insures an even coating and in many cases is better than placing the composition directly in the mould with a spatula or trowel. Crêpe paper napkins painted with flour paste make good material for backing, and paper towels or burlap spread with papier-mâché work very well for deer head casts. This paper is very absorbent and takes the paste readily. Paper casts may be waterproofed by painting the dry cast with beeswax dissolved in hot carbon tetrachloride. When dry, shellac over the wax, and the paper will be sufficiently waterproofed to withstand the moisture from a wet skin. Without waterproofing, if a wet skin be put on a dry paper cast, the moisture will strike into the paper and soften the cast which will warp and twist out of shape in drying. As an extra precaution, it is a safe plan to flow the inside of a dry paper cast upon which a skin is to be fitted with liquid plaster, gum arabic, and wood pulp, mixed. This makes a firm hard core for the paper to rest upon, and adds but little extra weight. Papier-mâché, made with gum arabic, will easily relieve from a plaster mould oiled with stearine and kerosene. Hot glue mâché will relieve from a mould greased with stearine and lard, half and half, melted together and thinned down with a little coal oil. When dry, brush it over with hot glue or flour paste. Then put the mâché directly into the mould without any intervening material for a parting. The mâché must, however, be given plenty of time to dry in the mould, otherwise it will break off in damp places and cling to the mould when the cast is pulled out.

Another method of casting hot glue mâché, is to paint the dry plaster mould all over with hot glue, without any previous oiling or greasing. Paint this with warm wax thinned down with carbon tetrachloride. Model in the mâché and backing and allow the whole to become bone dry. Then paint the back of the mould several

times with water, or place it in water. The moisture strikes through the plaster, softens the layer of glue, and relieves the cast. It is best for this method of papier-mâché casting, to waterproof the mâché by mixing in a proportion of white lead mixed with boiled linseed oil before the dry plaster is incorporated with it. If a cheese cloth covering is desired in the finished cast, damp cheese cloth may be stippled in the mould on the glue surface and then the mâché placed over this. This may be reinforced with wet burlap spread with mâché, or wire cloth may be inserted and mâché squeezed through the meshes with a trowel. For ordinary purposes, burlap is superior to wire cloth for stiffening, being less expensive, far easier to handle, and much more durable than light galvanized wire cloth.

Rock Casting.—To build up large rock masses or cliffs, thin slabs of plaster and burlap are made from moulds of the rock facing. These are cut and sawed and arranged on a wooden framework to whatever shape is desired. The joints are stuffed with newspaper, painted with water to kill absorption, and pointed up with mâché. When dry, the rock is painted with oil colors and turpentine, either by brushing or spraying or both. After the oil colors, dry colors—ocher and umber—are stippled on to kill gloss and get the proper effect. If the rock is to be exhibited outside of a case, and liable to have chips or corners broken off in handling or otherwise, it is a good plan to mix dry water color with gum arabic water, and color the plaster of which the rock is made up. Broken corners are then not so objectionable as when made in a clear white material.

If the rock is to be transported and lightness is desired, paper casts may be made and joined in the same general way. When assembling, dry paper casts may be dipped into water some time before being used, to relax them so they will bend if necessary. Broken rock surfaces may be duplicated, in reverse, by oiling the rock and making the paper cast direct, without using a mould. Of course the cleavage is reversed, but for many purposes this would not matter.

Large casts, where lightness is essential, are sometimes made by a quick process, putting pulp directly on the rock, or on moulds of the rock. These are greased with automobile hard grease, or

stearine and lard; and wood pulp, mixed with a little flour paste and glue water, is pressed and pounded in, and backed up with pasted builders' paper. When dry, this is very strong. This type of cast is much used in theatrical and moving picture scenery.

CHAPTER IV

BIRDS

SKINNING AND MAKING SKINS

Bird Skinning.—Field collectors usually prepare birds and small mammals in the shape of “skins,” as they are universally called, instead of mounting them. Making skins takes less time, they are more convenient to transport, are more available for study and comparison, easier to handle, and take up much less storage space. Dry skins prepared in this way may be relaxed and mounted at any subsequent time, as described later on.

Bird skinning and making “study” skins, is very mechanical work and any person of ordinary intelligence, with the desire to do so, may very soon master the operations. At first the work will proceed slowly, but with practice, speed will gradually develop, until in time a bird of the size of a robin may be skinned and “made up” in fifteen minutes or less. Bird mounting is much more fascinating, and it is here that the true artist may show his ability in reproducing the form, attitude, and general appearance of the living bird.

The better the condition of a bird before skinning, the easier it is to turn out a perfect specimen. Very badly mutilated birds, or those in which the plumage is bloody or disheveled should be avoided, unless the specimen be rare. For the beginner, blackbirds or jays are the best, as they are usually free from fat and have tough skins. Pigeons and ducks are difficult to skin and clean. Some of the latter are sometimes so fat that it is almost an impossibility to remove it perfectly and have any bird left, as the skin is so thin and tender that it literally falls to pieces in handling. The weight of the skin supported on the end of the finger, in some instances, is sufficient to punch a hole in it. Such birds should not be mounted unless absolutely necessary.

Before proceeding to skin a bird, first note the color of the eye. That of the feet, legs, bill and any other fleshy parts should be recorded. It is better to allow a bird to remain a few hours before skinning, in a temperate climate, as when fresh the blood and juices flow too freely and are apt to run and disfigure the plumage during the skinning operation.

Place a paper on the table and change it for another when it becomes badly soiled. Remove the plug of cotton from the throat, swab it out with fresh cotton until it is perfectly dry and clean, and allow a fresh plug to remain in. No measurements are ordinarily taken of birds, these being taken, if necessary, from the dry skin, in classifying.

Lay the bird before you, resting upon its back, the tail pointing toward you. With the fingers and scalpel handle, separate the feathers on the abdomen. If the bird be a small one, the feathers may be separated by a few puffs of the breath before the bird is laid down. With the scalpel, make an incision in the skin of the abdomen, from just in front of the rear end of the breast bone to the vent, as in Plate II, Fig. 1, care being used not to cut through the belly walls into the abdominal cavity. Sift a pinch of dry yellow corn meal along the cut to absorb the moisture and keep the feathers from clinging. Separate the skin from the flesh with the forceps, the flat end of the scalpel, and the finger nails, as far around toward the backbone as possible, on both sides. This exposes the knee joints. Take hold of the foot and push one knee joint up into view, as in Plate II, Fig. 2. Cut entirely through this joint with the scissors and, grasping the end of the bone with the fingers of one hand, with the thumb and finger of the other hand pull and roll the skin down on the leg as far as the ankle joint, as in Plate II, Fig. 3. The flesh and tendons on this joint may be removed later on, but while the leg is inside out, most collectors remove them at once. This is done by inserting the point of the scalpel between the tendons and the bone, just above the joint, and detaching them all. The edge of the scalpel or the thumb and finger are then used to roll the flesh, all in one piece, off the bone, leaving it perfectly clean. In order to save time, some collectors snip off the whole thing just above the joint with scissors. This should not be done, either for skins or mounting, as in the former it weakens the attachment of the leg to the dry skin, and

in mounting the bone is necessary to make a properly shaped leg. The other leg is treated in the same way.

Plenty of dry meal should be used all through the skinning process to absorb the blood and juices and keep the feathers from becoming soiled. Plaster and similar substances should not be substituted for meal, as more or less of the finer particles cling to the feathers and discolor them. Fine dry sand is sometimes used in emergencies and sawdust is sometimes recommended, but the latter has a tendency to stick in the feathers. Dry corn meal answers best as it not only absorbs blood and moisture but also forms a dry crust over them, thus protecting the feathers.

Both legs having been severed, press away the skin on either side of the rump, and with the point of the scissors, cut through the vertebra, or backbone, near the end, severing the tail stump entirely from the body. Be careful not to cut so close to the tail feathers as to sever their bases inside the skin, or they will fall out and ruin the specimen. At this stage an abundance of meal should be thrown on, as the abdominal juices are apt to flow freely. Stand the bird up on the end of the breast bone and with the scalpel handle and finger nails strip the skin from the body until the butts of the wings appear, as in Plate II, Fig. 3. With the scissors, clip first one wing, as in Plate III, Fig. 1; then the other, close to the body, and throw on plenty of dry meal.

After the wings are severed, the skin peels off the neck easily until the base of the skull is reached. Before skinning the head, it is best to snip off the neck near the body, thus getting the body out of the way, and no longer endangering the plumage with disfiguring juices from that source.

During these manipulations, the blood and fluids have been loosened up, and it sometimes happens that the throat has again become filled with them. When the plug of cotton is removed from the mouth, as it should be at this stage to reduce the size of the head, should it be saturated with moisture, it is proof that the throat is again filled up. This should be swabbed out with dry cotton and a pinch of dry meal dropped inside, otherwise in turning the head, the juices are forced out on the feathers.

The base of the skull is now exposed to view. By gentle manipulation and pressing the skin firmly against the skull with the thumb and forefingers and drawing forward at the same time, the



FIG. 1.—The opening cut in skinning.



FIG. 2.—The knee joint exposed and ready to be cut.



FIG. 3.—One leg disarticulated.



FIG. 4.—Both legs disarticulated and the butts of the wings exposed.

BIRD SKINNING

base of the skull is gradually pulled through the skin of the neck until the ears are reached. The skin at the ears is deeply rooted in the cavities of the skull. With the tips of the forceps, pull the skin out of the cavities. On large birds the scalpel must here be used. The eyes are next reached. Great care must be shown here to avoid cutting the lids or puncturing the eye balls. These are filled with fluids which, if allowed to escape at this stage, will badly disfigure the feathers of the head and neck. These parts should always be carefully protected, as, if once saturated with blood and body fluids, they are never quite the same again, no matter how carefully they may be cleaned afterwards. The eyeballs are covered with a thin bluish-colored membrane. Cut this membrane with the point of the scalpel, exposing the eyeballs in the sockets of the skull. The latter is now easily skinned to the base of the bill.

With the scalpel, or on larger birds a small piece of hack saw blade, cut the base of the skull completely through, crosswise, severing the head from the neck and exposing the brain. Remove the tongue with the scalpel point. With the scissors, make a V, on the under side of the skull, running parallel with the sides of the bones of the bill, the points of the scissors reaching into the brain cavity. The ends of these cuts, which correspond to the upper ends of the V, terminate at the cut previously made with the scalpel across the base of the skull. Make a third cut with the scissors across the apex of the V, and draw out the V-shaped piece of bone, bringing with it a mass of brain and muscle. The cuts are quickly made, three sharp strokes of the scissors being all that are necessary. Pick out the balance of the brain with the point of the scalpel. The eyeballs are next removed in the same way. After the remaining flesh is cut from the skull, leaving the hollow shell, it is completed, as shown in Plate III, Fig. 2.

Invert the skin of the legs and skin down as far as the joint. Cut away the flesh and tendons, leaving the bones intact, if this has not been done previously. Clean the flesh from the tail stump, being careful to remove the oil sac at the top of the root of the tail. Peel the skin over the wing bones from the inside, stripping the feathers (secondaries) from the bone. With the scissors, cut away all the muscles, tendons, and bones, leaving only the larger bone (ulna) in the middle joint of the wing, as in Plate III, Fig. 2. The skinning is now completed.

The method of skinning wings will depend somewhat upon what the bird is to be used for. If the finished specimen is intended for a skin, either for study or future mounting, it may have the secondaries stripped from the bone. This saves time in the field as the wing may be more quickly and better cleaned and poisoned by stripping the bases of the quills and turning the wing inside out. A wing prepared in this manner relaxes better and is more easily manipulated when the dry skin is soaked up for mounting at a future time. But if the bird, either large or small, is to be mounted while fresh, with either closed or spread wings, the secondaries should never be stripped, as stripping tends to mess the feathers more or less in the stripping process. In skinning the wings of small birds, they may be cleaned from the inside, without stripping the wing quills, by skinning down the front of the wing and reaching in the opening and removing the flesh and tendons. In larger birds, an opening cut is made along the under side of the wing, lengthwise of the bones. The inside is then cleaned through this opening, care being taken to open the under side of the wing-tip (wrist) clear to the end. The edges are then sewed together again, after poisoning the interior.

If any flesh or fat is found on the inside of the skin, this must be scraped off with a knife and a piece of hack saw blade, using dry meal abundantly to absorb the oil as it is released in the scraping process.

Turn the skin wrong side out as in Plate III, Fig. 2, and hold it over the box of poison (alum and arsenic, Formula 6). With a bristle brush, or a wad of cotton batting tied to the end of a stick, dust the whole inside of the skin with the dry preservative, giving an extra allowance to the base of the tail and skull.

Take a small wad of cotton, and, with the forceps, introduce it through the brain cavity into one of the eye sockets, holding a finger against the outside of the socket and packing the cotton against the finger, so as to leave a smooth surface. Treat the other eye socket the same.

The head is now ready to be turned right side out. If the skin of the neck has dried, which is liable to happen to beginners owing to the slowness of their skinning operations, wet it with water applied with a wad of cotton, so as to relax it. Coax the skin back over the skull, using the thumb and forefinger of each hand, with



FIG. 1.—One wing disarticulated.



FIG. 2.—The skin inside out and ready to be poisoned.



FIG. 3.—Turning the head right side out.



FIG. 4.—Putting in the filling.

"MAKING UP" A BIRD SKIN

the thumbs against the base of the skull, and the fingers pressing against the loose skin in front, gradually forcing the skull up into the skin, as in Plate III, Fig. 3. A little practice is necessary in order to do this nicely without ruffling the feathers of the head and neck. When the head is nearly through, turn the skin of the neck right side out, grasp the end of the bill, and with a little manipulation pull the head right side out again.

Take a steel knitting needle, or piece of stiff wire, and holding the bird by the bill, introduce the end of the wire into the eye opening, and work it back and forth between the skin and the skull, lifting the skin and working it forwards toward the bill. It will soon be found that the feathers have been readjusted, assume their proper positions, and lie smoothly. Individual feathers may be arranged with the forceps.

Ducks and woodpeckers, by reason of their large heads and small necks, will not permit the skull to be passed through the skin of the neck, without tearing the latter. It is therefore necessary to make an incision in the skin of the throat, from just behind the bill to the base of the head, long enough to allow the skull to pass through after it has been disarticulated from the neck vertebrae. After being cleaned, poisoned, and filled as before, the skin is sewed together again. Making the incision on the throat is ordinarily much better than making it on the side or top of the head, as is sometimes recommended. In mounting a duck hanging as "dead game," if it be decided beforehand which is to be the show side, the opening cut may be made on the reverse side of the head, or that next to the wall.

The skin now lies on the table, right side out and poisoned, and may be made into a study skin or mounted, the skinning being done in the same way for both, with the exception of the wings as already indicated. Should any blood or grease spots be found on the feathers, these should be removed now, as, if left on, they give the finished specimen an unsightly appearance. Bent quills may be easily straightened by holding them for a moment in a jet of steam from the spout of a kettle.

The ordinary method of cleaning blood or grease from feathers or fur is to sponge with a wad of cotton wet with soapy water. This is followed by sponging with turpentine or benzine; and plaster or meal is heaped upon the feathers or hair and the latter

agitated and beaten with a brush or stick, thus working in dry material to absorb the moisture. The feathers are finally fluffed by beating with a flat stick and then dusting with a feather duster or painters' dust brush. Turpentine and plaster is the old method and this answers very well for greasy white plumage, but for black or dark-colored birds, it is not recommended, as more or less of the plaster remains in the feathers and is sometimes quite noticeable in the finished specimen. For scientific purposes, where the specimens are to be used for comparison, turpentine and plaster should never be used on dark colored birds or mammals for this reason. Corn meal is better than plaster, as it is less apt to leave a residue on the feathers or hair, and the grit in the particles helps to scour and clean as well. It does not absorb so readily as dry plaster and therefore takes longer, but the results warrant its use.

One difficulty in using water on blood spots, especially in white-breasted water birds, as for example a white gull, is that the water dissolves the blood and the thinned solution stains the feathers. For birds of this kind, water should never be used for cleaning blood. Benzine or carbon tetrachloride, or a mixture of both, will clean fresh or dry blood or grease from feathers, without leaving any stain. Acetone alone, or in combination with either of the above is even better. Acetone will dissolve blood or grease from feathers or fur and is so volatile that in cleaning small areas, agitation of the feathers is all that is necessary to fluff them, no absorbent, such as plaster or meal, being necessary. In some instances a little corn meal may be saturated with acetone and rubbed hard on a dry blood clot with the fingers, the grit in the meal scouring the feathers and carrying away the blood. Large areas may be cleaned by first removing the blood and grease with pads of cotton saturated with acetone, stroking the feathers or fur from base to tip, they being supported underneath with the fingers of the other hand. When a pad becomes badly soiled, it is discarded for a fresh one, until the stain disappears. Finish the process with dry cotton. Acetone of second quality, known as "technical," answers every purpose. Acetone is very volatile and both the liquid and gas are very inflammable. It should be kept away from fire in stoppered bottles or closed tins. In cleaning feathers, remove the cork from the bottle, hold the wad of cotton over the mouth, tip up the bottle and saturate the cotton with the liquid. By vigorous

rubbing with the grain of the feathers, the blood soon dissolves and comes off on the cotton. The usual dry corn meal process is then used to hasten drying and fluffing. Sawdust or sandpaper dust is used almost exclusively in fur-dressing mammal skins, the latter being placed with dry sawdust in a revolving drum, and the sawdust later worked out of the fur in a revolving "cage," or wire mesh drum.

I have known custom taxidermists, in order to save time and labor, to degrease fresh duck skins by soaking them in benzine and then drumming with sawdust; but this treatment is too strenuous for feathers and is apt to roughen them, besides leaving a permanent residue of fine particles of sawdust, as with dry plaster. The sum and substance of the whole matter is, that feathers of certain kinds, if once smeared with blood and grease, can never again be made to appear exactly like the original. The best way, by far, is never to allow them to become soiled, and a few moments spent in properly caring for a specimen when first taken, may save much time later on, and with a more perfect result.

Making up the Skin.—Wrap the leg bones with a fluff of cotton batting to replace the muscles that were cut away, and turn the legs right side out again. Bring the wing bones together inside the skin about as close as they were in life, and tie them together with a piece of thread to keep them from separating. Pass a needle and thread through the nostril and bring the ends around the bill and tie them tightly to keep the bill closed.

Take a handful of cotton batting a little larger than the body of the bird, draw one end to a long point and wind this point around the end of the knitting needle or piece of stiff wire, to imitate roughly the neck and body of the bird. The extreme tip is made small and pointed by twirling it between the clamped thumb and forefinger. Pass the point of the wire, with the cotton rolled about it, into the skin through the opening in the body as in Plate III, Fig. 4, and work the point up inside the neck skin until the tip is driven firmly up into the throat and wedged tightly between the upper and lower bills (mandibles). Work the body skin forward to reduce the length of the neck and hold the skin up by the wire and adjust the wings. Lay it upon its back on the table and work the cotton into the body, filling the skin completely. Withdraw the wire, leaving the cotton all in one piece, reaching from

the throat to the base of the tail. If too much cotton has been used, a portion may be subtracted. If more filling is required, more cotton may, of course, be added. The skin should be plump and full and the neck kept short. If necessary, a few stitches may be taken to bring the edges of the belly skin together, but ordinarily this is not done. Cross the legs as indicated in Plate IV, Fig. 1, and after rolling the skin over, first on the back and then on the breast, a few times and arranging the wings and feathers, the specimen is ready for the label.

Proper labeling is a most important item and should never be neglected. The record of a certain species from a certain locality, to show the distribution of that species, is sometimes as important as the actual specimen. A specimen without proper data is sometimes absolutely valueless. The label should record, in waterproof ink, the locality where taken, the date of capture, the name of the collector written in full and not simply initialed, and the sex. Among naturalists the world over, the spear and shield of Mars (♂) is used to indicate the male sex; and the mirror of Venus (♀) the female, while the word "Juv." (signifying Juvenile) is used for young individuals. Any remarks about the colors of the eye, legs, feet, bill, etc., with the approximate altitude in some cases, should be entered. A notebook, or field catalog, should be kept and the specimens and data entered in it, the catalog number being also written on the field label. The label should not be attached with a flimsy half-hitch, but firmly tied with stout cotton thread, as indicated in Plate IV. Linen thread should never be used as it rots and falls to pieces in time and does so much more quickly if exposed to strong light. The label should be of stiff paper, not less than $2\frac{1}{2}$ x $\frac{5}{8}$ inches, and rubber-stamp ink should never be used, as it lacks permanency. The original field label should always remain on the specimen, a duplicate label with the name of the institution owning it, the scientific name of the skin, and other data, being attached when entered in the museum accession catalog.

Great care should be used in determining the sex of specimens. After the bird is skinned, lay the body upon its left side. With the scissors, make a straight cut on the upper or right side of the body from the thigh forward through the ribs, thus opening the body and exposing the inside of the back. Press aside the intestines



FIG. 1.—The bird skin in position on the copy.



FIG. 2.—The head covered.



FIG. 3.—One side covered.



FIG. 4.—The skin completely wrapped.

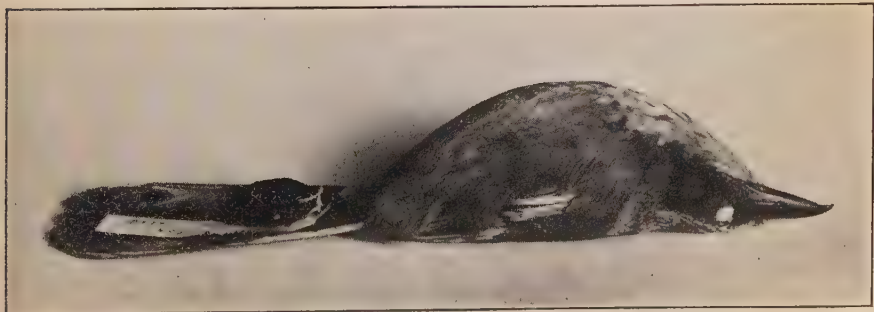


FIG. 5.—The bird skin completed.

WRAPPING A BIRD SKIN

with the forceps or scalpel, when the sexual organs will be found, bound to the walls of the center of the back. The male organs (testes), two in number, are usually dull-whitish elliptical bodies, lying side by side. The female organs (ovaries) are a mass of small round bodies lying in a cluster, like a miniature bunch of grapes. These organs are very easily determined during the beginning of the breeding season. But after that they decrease in size and are then sometimes very difficult to detect, even with the aid of a hand lens. Young birds, specimens that are shot badly in that particular spot, or others in which decomposition has softened and disintegrated the interior tissues, are sometimes impossible to determine. Unless absolutely certain of the sex, it is better to mark on the label, "sex undetermined," rather than hazard a guess and mark the specimen wrongly. Falsehoods or "fake data" are to be deplored; and any collector making use of them, if once found out, will soon be advertised as unreliable and collections made by him will not be accepted by the scientific world.

These details having been attended to, the skin is ready for wrapping to hold the feathers in place until it is dry. Turn the skin upon its breast and see that the wings lie in their proper position and that the tips come even with each other. Then turn it upon its back, and adjust the feathers by picking up small bunches of them with the thumb and finger and allowing them to fall of their own accord into their natural positions. This is the best way to properly adjust plumage, and individual feathers that refuse to lie in place may be adjusted with forceps. Split a sheet of cotton by carefully drawing it apart and separating the layers until a thin sheet, large enough to envelop the skin, is obtained. Absorbent cotton answers nicely for small birds, but sheet cotton is better adapted for large ones. Lay the skin upon the sheet of cotton as in Plate IV, Fig. 1; and carefully arrange the wings, legs, and tail. Lift the cotton projecting beyond the bill over and down upon the head and neck, as in Plate IV, Fig. 2. Lift up the cotton from the left side and pass it over the body to the other side as in Plate IV, Fig. 3. Then finally fold over the cotton from the remaining side so as to overlap that of the left side, as in Plate IV, Fig. 4. In this way the skin is neatly rolled in a thin sheet of cotton through which the shape of the skin may be seen and perfected, the fibers of the cotton interlocking and holding the skin

in shape. For very large birds, a sheet of paper or a square of cheese cloth or burlap may be used instead of cotton, the bird being laid upon its back in the center of the sheet and the sides brought up over the breast and pinned together to keep the wings in place while drying. The wrapped skin is laid away to dry, resting upon its back. The next day, it may be unrolled and examined. If the head or tail or any feathers are out of place, these are readjusted and the skin rewrapped. When thoroughly dry, the cotton is removed and the skin, as in Plate IV, Fig. 5, is ready to be placed in the collection.

It sometimes happens that more specimens are collected or brought in fresh than can conveniently be taken care of before they spoil. If a cold storage warehouse is available, fresh specimens may be kept below freezing point for weeks in fair condition for skinning, except that the legs, feet, and wings dry somewhat. An ordinary household refrigerator will help some, but the temperature is not low enough to retard decomposition for longer than a day or two. By far the best method is to skin all the birds as quickly as possible, and poison them in the usual way. A small pad of damp cotton is laid inside and the skin brought together over it so none of the feathers come in contact with the cotton. A tight box or can with a hinged or removable lid or cover is taken and a piece of galvanized wire cloth cut to lie flat inside and arranged with blocks of wood at the corners so as to raise it an inch or more from the bottom. A wad of cotton, or a slab of plaster made to fit into the box, is saturated with water and a little lysol to arrest decomposition, and placed under the netting. Bird or small mammal skins placed in this dampening box will remain soft and pliable and in first class condition for a week or longer. The feet and legs dry somewhat, but if desired for mounting these may be relaxed by wrapping them with wet cotton.

Fat and grease should always be carefully removed from the inside of any skin. Fat ducks and other water birds are usually the hardest to clean. A substance that would destroy fat and at the same time not wet or injure the skin and feathers, would be a great boon to the collector, but this magical medium has not yet been discovered. To properly prepare the skin of a real fat duck means scraping and hard work and plenty of it, but the grease must come out if the skin is to be kept for any great length of time. If

not removed while fresh, in time it will come out of its own accord and stain and ruin the specimen. It will also rot, or "grease burn," the skin itself so that should the skin ever be relaxed for mounting, it disintegrates and falls to pieces like wet blotting paper. Sometimes greasy skins will fall to pieces with dry rot. I once knew of an instance where several Labrador ducks, that had been mounted for a number of years, were remounted for a group. When fresh, these specimens had not been properly degreased and cleaned, and when relaxed, the skins literally fell apart. The pieces were sewed fast to a thin sheet of rubber in remounting them, involving much time and patient labor.

A sharp knife, a piece of a hack saw blade, a tablespoon with a wooden handle made to fit the palm of the hand, a flat tray or milk pan, and plenty of dry corn meal are the machinery required to rid the inside of a fat duck of his supply of grease and oil. Put the meal into the pan or tray, and break up the membranous fat lining with the hack saw teeth. This releases the oil, which is scraped off with the spoon and knife. All through the process, dry meal is heaped upon the released oil, which is absorbed by the particles of meal. Hot corn meal works better than cold. By thus scraping with the saw teeth, knife, and spoon, and using liberal quantities of meal, the grease and oil are removed. The teeth of the saw are also useful in reaching the depressed surfaces between the bases and tracts of the feathers that protrude inside the skin. The skinning and cleaning of three fat ducks, if the latter be well done, represents a good day's work, and the preparator who can properly clean a real fat mallard skin without filling it full of holes, is yet to be born.

It often happens that a bird is shot through one or both eyes, puncturing the eyeballs. This generally results in a mess when the head is skinned and turned right side out again, as the squeezing process of inverting the skull through the skin of the neck forces the eye fluids out upon the feathers. Before starting to skin a bird, it is a good plan to examine the eyes, and if they have been punctured by a shot, to remove them from the outside before skinning the head. Insert the point of one of the blades of a pair of pointed scissors through the eyelid and pull out the entire eyeball through the lid. Sprinkle in a little dry corn meal and fill the inside with a pinch of dry absorbent cotton, rolled up and inserted

with forceps. The large, tough eyeballs of hawks and owls will not pull out through the eyelid. Take hold of the broken eyeball with forceps and with small pointed scissors cut and gouge out the center and absorb the fluids with pads of dry cotton, and finally pack the cavity with dry cotton before skinning. If any fluid gets on the feathers during the absorbing process, wipe them off with a pad of cotton wet with acetone, and dry with corn meal. This process of removing a broken eyeball sometimes takes a little time, but it is better than messing the head and neck feathers later and being compelled to clean them.

In making up bird skins, individual collectors have their own special methods. In making small skins, instead of introducing the cotton into the throat by wrapping it around a knitting needle, the tip of the cotton may be grasped with fine forceps and placed in position. Another method is to wrap a wooden toothpick with cotton to the size of the neck and introduce this into the skin, leaving the toothpick in permanently to reinforce the neck in the dry skin. By this method, the toothpick lies against the skin in the center of the back and a round ball of cotton to fill out the body is put in afterward. Another method is to wind a cotton or tow body on a wire, as in making an artificial body for mounting a bird, and inserting this in the skin, the wire in the neck reinforcing and stiffening it. Owls, having a large head and small neck, are best stiffened by snipping off the head from a pin, driving it base first into the end of a small stick, winding cotton around the stick to form the neck, inserting it in the neck skin in the usual way and driving the projecting pin up into the skull near the base of the bill. The body is then filled as usual. Long-necked birds, such as herons and geese, may have a stiff wire inserted and after the skin is made up, if necessary to reduce the length of the skin, the head and neck may be bent around to the side of the bird as desired. This is better than allowing the head and neck to rest upon the back of the skin, as by the latter process the feathers of the back of the bird are more or less hidden and distorted by the head and neck.

Mr. R. H. Beck, who has probably collected and made up more and better water-bird skins than any other man who ever lived, uses the following method: In skinning, the opening cut is made under one wing, instead of on the back or belly. This is an advantage

in skinning water birds, which are to be made into skins, especially white-bellied ones, since if opened on the belly, more or less grease is apt to be absorbed by the feathers in skinning or come out through the opening ultimately, and oxidize and stain the feathers paralleling the opening a dirty yellow color. For mounting, making the opening cut along the center of the back is preferable to the belly opening on a white-breasted bird. Opening under the wing is good, but it is difficult to arrange the wires, etc., in mounting.

Instead of putting in the filling loose, as already described, Mr. Beck winds a body of excelsior or tow around a stick, using the natural body as a guide, the stick protruding from one end, after the same general principle as that used in mounting birds, the wire being replaced by the stick. The end of the stick is whittled to a point, wrapped with cotton or tow, and introduced into the bird skin, and the opening under the wing sewed up. To hold the wings in place, a long needle and thread are used, the thread passing crosswise through the body, over a few of the wing quills and back again out the other side, and the ends of the thread tied together over a few of the wing quills of that side. This holds up the wings and keeps them clamped tightly to the body. The skin is then wrapped in the usual way to keep the feathers in place while drying. This makes a very substantial skin when dry, and the opening cut being under the wing, leaves no chance for oil or grease to work out and disfigure exposed feathers.

The legs of large birds, especially waders, should have the tendons removed from them by making an incision in the sole of the foot with the scalpel, after the bird is skinned. A stout awl is then worked through this opening under the tendons; and by pulling vigorously, the tendons are drawn out of the leg and cut off short at the foot. In large birds, if the tendons are not removed, the legs are apt to become putrid and lose their scutes. The bills, legs, and feet should be painted outside with arsenic water or sodium arsenite to keep bugs from eating them. In the case of young hawks, eagles, ospreys, and other birds having a plump, fleshy foot, the tendons of the toes should also be removed by splitting the bottom of each toe, and if for mounting, filled with papier-mâché and afterwards sewed up, as with mammals. Instead of splitting the toes, the bones of each toe may be encircled with a stiff piece

of wire, hammered flat and filed round, and set in a wooden handle, like a small screw driver. In mounting, mâché is then injected with a syringe, as in mounting some mammals.

In natural history museums and private collections, bird skins are generally kept in square air-tight metal boxes, fitted with sliding trays to hold the specimens, the entire front of the case or can being arranged to lift off and clamp on tightly. Naphthaline crystals are sometimes kept in the cans to repel moths, and from time to time the interior is fumigated with carbon bisulfide to destroy any insect life that may exist. Fresh specimens, like hawks or ground squirrels, are sometimes infested with lice or fleas. It is a good plan to bisulfide such specimens before skinning to keep the preparator from becoming the host.

MOUNTING

Mounting.—Successful bird mounting is an art in itself; and requires skill and artistic ability to copy form and attitude; and a readiness to reproduce what is observed from a close study of the living bird. An opportunity should never be lost to study live birds in the field, using good field glasses and making notes, sketches, and photographs of them. Patience is essential, and much practice is required in order to master the mechanical operations. The latter must come by degrees, and the beginner should be satisfied if his first large specimen stands upon its feet alone.

The first essential to the production of a successfully mounted bird is that the feathers be smooth and not mussed and ruffled in the skinning operation. A bird skin that is perfectly smooth before mounting will require much less time and work to properly mount, and will also produce a much finer result than one in which the plumage is in a medley of disorder. To skin a bird so the feathers remain perfectly smooth requires long practice, and it is therefore recommended that the beginner make study skins of his first specimens in order to perfect himself in turning out smooth, clean skins, and which are in proper condition for mounting. A bird that is intended for mounting while fresh is skinned in the same way as for making skins, with the exception of the wings. As before stated, the secondaries should not be stripped; and the entire wing bones should be left in, in order to secure the proper bends, and also for the attachment of wing wires.

In mounting, the first step is to make an artificial body of excelsior or some other coarse fibrous vegetable material through which a pointed wire may be driven and clinched, to support the mounted specimen. Cotton or fine fibrous material will not answer as it is difficult, when the material is compressed and wound into a hard ball, to force a wire through it. Coarse tow or oakum will answer for small birds, but fine excelsior, or wood fiber, is best. It should be sprinkled or wet with water some time before using, as this makes the fibers more pliable and harder when dry.

With the natural body as a guide for form and size, roll up a ball of dampened excelsior and, with a spool of thread, compress and wind it into the general form of the natural body, but considerably smaller. If too small, wisps of excelsior may be added and bound fast. If too large, some of the thread must be unwound and a portion of the material extracted. From time to time as the winding progresses, lay it alongside of or over the natural body so as to make certain of the size. To flatten the sides, lay it on the table and strike it with the clenched fist. The wound body should be smooth and as hard as possible in order to secure stability for the support of the wires which are to be clinched into it to support the mounted bird. Be sure that the artificial body is considerably smaller than the natural one, as in Plate V, Fig. 1. In winding bodies for small birds, a flattened oval is all that is necessary. In making artificial bodies for large birds, it is difficult to get them hard enough to offer a firm support, by the ordinary method of winding. Such bodies are best made by first winding a long roll of dampened excelsior, making it as hard as possible by compressing and winding with number 25 or other strong linen thread. The roll is then bent into an oval a little smaller than the natural body, and the open center filled with a hard wound ball of excelsior. The sides are then built out by the addition of more excelsior, and when well wrapped, this makes a firm body for large birds.

Two methods of mounting birds are in use by professional taxidermists. One consists in making an artificial body of the exact size and form of the natural body. The second, and the one recommended here, is to make the wound body much smaller and fill in between the body and the skin with loose fibrous materials in order to work out form and also to puff certain feathers.

A piece of soft galvanized or tinned iron wire is selected, several inches longer than the neck and body of the bird, and heavy enough to support the head rigidly in any position in which it may be placed.

For a bird of the size of a jay, number 18 is about right. The wire is sharpened on both ends on a power emery wheel or by cutting on a long bevel with cutting pliers and perfecting the point with a flat file. The wire is straightened by hammering it upon the table with a hammer or mallet. Small sizes of wire may be straightened by attaching one end to a nail driven into the bench and pulling hard on the other end so as to stretch it slightly. When slackened the wire remains straight, and may be cut into the required lengths. Should the wire be dirty or rusty, it may be rubbed with a piece of emery cloth.

One end of the wire is driven into the wound body at the point where the neck joins it, and by twirling between the thumb and finger, is driven completely through and out at the tail end. The projecting tail end is turned over into a hook or staple and hammered back into the body, keeping the wire from turning and offering a firm support for the head and neck. Cotton, or long-fibered tow, is wrapped firmly around the neck wire to fill out the skin of the neck, as in Plate V, Fig. 1. Wires for the wings are now cut and sharpened. If the bird is to be mounted with spread wings, a heavier wire will be necessary than with closed wings, as the latter require only a very small wire to hold them in place. It is more difficult for a beginner to mount small birds by inserting wing wires, but the advantage of wired wings is the facility with which the wings may be later adjusted. They are under perfect control and may be placed in position more easily and perfectly than by simply pinning them to the body. Very small birds may have the wing bones tied together inside, as in making skins, and do away with wing wires altogether if desired. Or a stitch may be taken through the scapular tracts on each side to hold them together. This has the same effect as tying the wing bones together, and is sometimes done to take its place when the wing bones are broken and missing.

In putting in wing wires, one end of the pointed wire is introduced from the inside of the skin and lying close to the under side of the bones, reaches out into the bones of the wing tip, where the point lies embedded. The wire is tied to the wing bones with



FIG. 1.—A natural body and an artificial one.



FIG. 2.—Coupling the legs to the body.



FIG. 3.—Arrangement of wires in the body.

thread about the center and near the end of the humerus. If the wing has been opened, as it should be in large birds, after tying the wire fast, the edges of the skin should be neatly sewed up.

As the leg wires are apt to be in the way in coupling the wings, the latter are first coupled, or made fast to the body. A small ball of cut tow is grasped with the forceps and worked up inside the neck to the base of the skull to fill out the skin at that point. The wound body with the long neck wire protruding from it is now taken up. The point of the wire is worked up inside the skin of the neck and through the open bill. This is better than running the wire up through the skull and out through the top of the head. The cotton of the neck is pushed up and brought into firm contact with the base of the skull by bending the wire at this point. After the body is in place, a pad of cotton or tow, cut up fine with shears, is laid inside the skin between the wings. One of the sharpened wing wires is forced through the wound body and out the other side, the wing bone brought into its proper position, when the wire is turned over into the form of a staple and driven back into the body, as with the legs shown in Plate V, Fig. 2. The other wing is treated likewise. These are now adjusted by turning the bird over, and if more filling is required on the back, additional cut tow is introduced with the forceps.

We are now ready to wire the legs. Wires are selected which are heavy enough to support the bird rigidly, and cut into lengths long enough to allow several inches above the leg bone for coupling and the same from the bottom of the foot for attachment to the pedestal or perch. For a bird the size of a jay, number 18 annealed iron wire is about right for size. These are sharpened on one end, and run up the inside of the leg, beginning generally at the center of the foot. By rolling or twirling the wire between the thumb and finger and pushing forward at the same time, the point gradually works its way up the tarsus or leg joint, between the skin and the bone, until the joint is reached.

The wire should pass at the back of this joint, when the leg is turned inside out, exposing the point of the wire. Seize it with the pliers and draw it up and slide it back and forth in the leg a few times so it moves easily. The other leg is treated similarly.

When it is desired to represent a bird as walking, in which case the ball of the hindmost foot is raised from the ground, the wire

is started at the center of the bottom of the middle toe, at the point of juncture with the ground. When treated in this way, the wire at the bottom of the foot is not seen in the mounted bird. Sometimes it is convenient to use a long slender awl to run up the leg first, to facilitate the insertion of leg wires. When the tendons have been withdrawn as already described, there is no difficulty in inserting leg wires. If the legs are at all dry, they should soak in a bowl of water to relax before introducing the wire, otherwise the skin of the leg will burst and mar the specimen.

After the leg wires are in place, a fluff of cotton or tow is wrapped around the leg bone and wire, and the leg wires coupled to the body in the same way as the wings, by forcing the pointed wire through the hard body, turning it over and driving it back again, thus holding the legs firmly and offering a rigid support for the specimen, as shown in Plate V, Fig. 2.

The most common fault with beginners in coupling the legs, is that they couple them too far back on the body. The exact spot where the knee joins the body is determined somewhat by the attitude or position of the bird. If the bird is leaning forward, the leg, in order to preserve the balance, or center of gravity, moves forward. It is better by far to couple the legs too far forward than too far back. If too far forward, they may be slid back on the wire, thus bringing them back to the required point. In large birds, especially waders, the position of the knee with respect to the body is all important. In a feeding wader, when posed with a long stride, the forward knee is very much in advance of the other. In order to adjust the legs properly, in birds of this kind it is a good plan to introduce the point of the leg wire into the body at about the point where the head of the femur enters the socket of the pelvis in the living bird, as indicated by the X and dotted line in Plate V, Fig. 3. After being coupled, the legs are then slid back on the wires and the knee bend made at some distance from the body, thus producing a wire femur, and permitting the same latitude of motion in the knee as existed in the living bird.

The legs, having been coupled, are brought together parallel with the body and bent into the approximate position they are to occupy in the finished specimen. To hold the tail in position, a long sharpened wire is introduced from the under side of the quills

running through the tail stump and into the body. Sometimes this wire is put in after the bird is mounted on the pedestal. The body having been made smaller than the natural one, there is now plenty of room between the skin and the body for soft filling to work out the form. The skin should be loose all over. If it be tight, the feathers can not be adjusted properly. Finely cut tow, or cotton for small birds, is now introduced in small loose bunches with the fine forceps until the skin, including that at the base of the tail, is full all around. If the opening cut be kept small, do not attempt to sew the edges of the skin on small birds, as the sewing has a tendency to tighten and draw the skin so the feathers cannot be properly arranged and fluffed and the form worked out. The bird is now ready for the perch or pedestal.

For walking birds, a flat piece of board will answer for a temporary pedestal. For perching birds a T perch, with a flat top or one at an angle, is made by nailing the T to a flat board base. If the specimen is to be exhibited upon a rustic base, such as a natural branch or burl, it may be mounted directly upon it and thus save time later on in transferring it from a T perch. But for perching birds, the pine T perch is ordinarily used and the specimen later transferred to a permanent one. Two holes are drilled through the top for the reception of the leg wires and the specimen placed upon it, the feet being drawn down until they rest firmly upon the crosspiece of the perch, when the excess wire is twisted around the perch to offer a firm support.

Thus far, the work has been almost purely mechanical, but now commences the artistic part of the operation—giving the bird the balance, attitude, character, and appearance of life. A good drawing or photograph should be secured, and having decided upon a pose, this should be worked out.

The specimen stands at an awkward angle, the head, tail, and many of the feathers awry. The legs are first bent at the knee until they assume the proper angle. The head and neck are next adjusted. In doing this, it is a good plan first to bend the neck down very low. Then place the forefinger across the top of the base of the neck where it joins the body, and with this finger pressed down firmly, bend the head and neck up into position. This insures a slight depression at this point. The wings are now adjusted, and by reason of the supporting wires, will stay wherever

placed. The tips should be even, not one beyond the other. Bunches of feathers all over the body are picked up with the thumb and finger and allowed to fall back into place, thus taking their natural positions. The wire projecting from the bill is cut off and the latter closed by tying it with a thread, provided the bill is to be closed in the finished specimen.

If necessary, one or both wings may be raised and a small incision made in the body skin under the wing butt. Through these openings the loose filling is adjusted with the forceps, or a "pusher," made by fastening a piece of stiff wire in a wooden handle, hammering the tip flat, and filing a notch in it. More filling may be introduced or some extracted at certain points, whenever necessary to secure the proper form, when the wings are thrown down into their proper position again. When these are perfectly smooth, a small wire clamp is made by bending over a piece of soft wire, or what is better, cotton or silk-covered wire, or wire about which a fluff of cotton is tightly twisted. These clamps are placed on the wings to properly space the quills and hold them in place while drying. A wire clamp, or two strips of cardboard, one above and one below the tail feathers and held in position by a pin at each end, spaces the tail quills and holds them in place. Without a clamp of some kind, the tail feathers will droop and twist out of shape in drying.

The toes are pinned to the perch. This detail should never be neglected, as much of the character of a perching bird lies in the feet, and these should always be made to grasp the perch tightly, especially when the specimen is finally transferred to its permanent perch. To hold the feathers in place while drying and also to work out the final drawing and details of the specimen, the feathers are wrapped with thin thread or, what is better, a thin soft threadlike material known as "winding cops," which is made for this purpose and is for sale by dealers in taxidermists' supplies. Small squares of cardboard strung on a long slender pin or thin pointed wire, are driven into the body above and below. Hooked wires may be used instead of the cardboard if desired. With the winding cops, the bird is wrapped or wound, by binding down the feathers where they need depressing and allowing the thread to rest upon the cards or in the loops of the wire when the feathers do not require binding down to work out the form, as shown in Plate VI, Fig. 1. The



FIG. 1.—Mounted California Jay, showing the method of binding the feathers to hold them in place while drying.



FIG. 2.—Mounted bird, with the skin of one side removed, to expose the interior.

THE COMPLETED BIRD

pins or wires serve also to keep the thread from slipping during the winding process. If certain feather tracts show a disposition to stand awry, it is because of some interior fault and should be corrected before winding. If simply bound down, when the wrapping is later removed, these feathers will again resume their faulty appearance. The wrapping is intended not so much to hold feathers in place as it is to keep them from drying out of place. They should therefore be made to lie of their own accord just exactly where desired, and then lightly wrapped, the final touches being given with fine pointed forceps. Owing to the shrinkage of the skin, which leaves the eyes too prominent or bulging if put in while the skin is fresh, the eyes are better inserted after the specimen is dry, relaxing the lids by introducing a small piece of wet cotton between the open lids and keeping it wet by squeezing drops of water upon it from a fluff of wet cotton held in the hand. This may be done at any future time.

After the wrapping and final adjusting of the feathers, the specimen may be put away in a dustproof place to dry, preferably in a glass case with hinged doors.

Further Information on Bird Mounting.—In mounting birds with spread wings, supporting wires are introduced in mounting exactly the same as with closed wings, as already described, the only difference being that a much heavier wire is used in a spread wing. The final arrangement of the feathers is left until the bird is placed upon the perch and posed. The wings are then perfected by supporting the quills from beneath on long wires driven into the body, the wires being curved as desired. Strips of thin cardboard are then clamped on by driving pins through both at different points and spacing the feathers, as shown in the jay's tail in Plate VI, Fig. 1, the cardboard being placed one above and one below. Birds may be represented as flying by suspending them with fine aluminum wire tied to the loop of a heavier wire anchored in the body of the bird. Another method, where a supporting wire would be objectionable, is to insert in the wing, when mounting, a wire heavy enough to support the entire mounted bird, allowing the wire to extend beyond the longest wing feather (primary). This wire is then firmly fastened to a branch or point of rock past which the bird is represented as flying, and concealed so as to escape observation from a side view of the bird.

Tail feathers in small birds are usually spread with wire or cardboard clamps, as already described. In large birds, the tail is spread by sharpening a small smooth wire and, by twirling it between the thumb and finger, driving it crosswise of the tail, through the quills, as close to the base of the tail as possible so it will be concealed by the under tail coverts. The feathers are thus all strung upon a wire, and may be spaced and spread as desired. In this method, there is no danger of the feathers drooping or changing their position later on. In small birds, only the outer feathers on each side of the tail may be strung on the wire, all the others simply rest upon the wire. This is a quick and sure way of spreading tails, as there is no danger of the quills drying out of position, as sometimes happens if the clamps ordinarily used are taken off before the bird is thoroughly dry.

In mounting small birds, greater freedom may be acquired in lengthening or shortening the necks, if the whole neck be filled with a roll of chopped tow, introduced by grasping the roll lengthwise with fine forceps, and then withdrawing the forceps. This leaves a flexible neck. The neck wire projecting from the body is left without any wrapping, and the pointed end is worked up through the soft neck filling, and out through the bill in the usual way. Greater latitude is allowed for posing the necks of small birds by this method.

Fresh bird skins sometimes shrink badly about the head in drying, the reason being that the soft filling materials used offer no resistance to the drying skin. Dry bird skins that have been relaxed and mounted generally hold their form much better than freshly mounted ones. To obviate the shrinkage of heads and necks, especially in large thick-skinned water birds, instead of filling them in the usual way by the methods described, it is far better to fill the head and neck full of fine ground cork mixed with shellac, as described for mounting small mammals. If cork dust can not be procured, fine sawdust will answer. The dry material is placed in a basin and shellac (gum shellac dissolved in denatured alcohol) poured in. Just enough shellac to dampen the mixture slightly, after being well stirred, is all that is necessary, leaving the mixture so that it will run freely and settle into cavities when shaken, and tamped or packed with a small ramrod. Before the body is inserted, the skin is turned upside down and held with the

head hanging free. With a tablespoon, the whole head and neck are filled full, and the material shaken and tamped into every part of the skin of the head, the bill being tied shut so the grains will not run out. A wad of chopped tow is placed against it, forced into the skin to dam the cork so it won't run back into the body when the specimen is turned right side up. The body, with the neck wire not wrapped with cotton or tow, is then put in and the mounting proceeded with in the usual way. The skin of the neck may be compressed and modeled into any desired form, and will hold its shape when dry, as the shellac evaporates, leaving the grains of cork glued together forming a solid firm mass. Ducks and other game birds mounted as hanging "dead game" pieces are quickly and easily done by this method, the whole body being filled around the excelsior core with the cork-shellac composition and the opening cut sewed up. The soft material inside allows for whatever outside modeling is desired. Before skinning a duck or other bird which is to be mounted as "dead game," the dead, relaxed bird should be hung from a nail by one foot, and a piece of blank paper placed behind it. The outlines of the bird are then traced on the paper and the mounted bird hung on the nail and made to conform to the tracing. It is also an advantage to have a duplicate dead bird to serve as a model, in addition to the tracing. In order to reproduce any object, it is much better to have the actual object as a model, rather than trust to the imagination. The only perfect work that is done in figure painting or sculpture is performed by copying living models. One of the best sculptors of the human figure that this country has ever produced, once told me that he could make a nude statue, without the use of a living model, which to most people would seem perfection itself. But to him, even though from long years of practice and experience he had familiarized himself with the drawing and modeling of the human figure, the model would be very far from what it would have been had he modeled from life.

Fresh naked heads, such as turkeys and vultures, should be cut off entirely and cast in wax or celluloid, colored, the hairs or bristles afterwards set in place, and the artificial head attached to the mounted body skin. The natural skin shrinks and dries and it is a difficult and costly undertaking to model a dry turkey head in wax on a mounted skin. In some domestic fowls, the combs and

wattles are also cast while fresh and these fastened to the dry head skin after the bird is mounted.

The collection of hummingbirds in the Los Angeles Museum is beautifully done. They are the work of Dr. John A. Hornung, and are mounted by a method of his own devising, as follows: If the bird be badly shot, it is unfit for mounting. If in good condition and fresh, it is skinned over the rump in the usual way, but the opening cut is made longer, reaching forward to about the center of the breast. The tail is first disarticulated and then the legs. The balance of the skinning is performed as already described. After poisoning, the skin is filled with dry cotton as in making a study skin. A pin is driven into a sheet of cork covered with white paper, so the pin holds securely. A match is cut off shorter than the length of the pin beyond the cork to serve as a perch, and a thread tied near one end and a second thread near the other end, the loose ends hanging down. The match is run through the toes of the hummer, and these tied in place securely with a piece of fine thread. No wires are used in the legs. The match, with the bird upon it, is tied fast to the pin, using the free ends of the thread previously tied on for this purpose, the cork lying flat on the table with the bird resting against the paper. A fine pin or pointed wire is driven through the fore part of the skull into the cork, the pin being shifted until the head is properly posed. Wire clamps are placed on the wings and tail as usual and pins, driven into the cork at different points around the body, give it the proper pose and form, when the specimen is set away to dry. The pins are then removed, the thread binding the feet to the perch severed, and the bird removed from the perch and cork. The eyelids are relaxed with wet cotton and eyes inserted as usual. The feet are relaxed by wrapping them with wet cotton and when they are soft, a piece of black silk thread is tied fast to each leg just above the foot, leaving the loose ends hanging.

Having selected the twig upon which it is desired to perch the bird, a small hole is drilled through the perch, and a piece of small pointed wire passed through the hole and wrapped neatly and tightly once or twice around the twig for a firm support, the pointed end of the wire projecting from the top of the twig and being an inch or so longer than the bird. Starting at the abdomen, the bird is worked down upon the wire, which comes up through the body

and neck and out through the top of the head. The bottoms of the feet are touched with liquid glue, the relaxed feet made to grasp the perch, and the threads tied underneath and the ends cut off. When the bird is properly balanced, the wire projecting above the head is snipped off, leaving the bird supported on the twig by the central wire and the feet.

Dry bird skins may be relaxed and mounted at any time by soaking and softening the skins with water. Old mounted birds may also be remounted by treating the skins in the same way. As a rule, the longer a bird skin has remained dry, the more difficulty there will be in softening it again.

There are a number of ways used by professional taxidermists to relax dry skins, but the simplest method is to cut the stitches in the belly of the skin, and remove the filling. The inside is then packed full of pads of wet cotton. The bends of the wings, the head, feet and legs are wrapped with flat pads of wet cotton and the whole covered with a wet cloth and left overnight to relax. In large birds, the legs and wings, which require the longest soaking, are wrapped with wet cotton a day or two before the body is soaked up. In some instances it is better to cut off the legs at their junction with the body and treat them separately.

When the skin is relaxed sufficiently to turn inside out, it is by no means yet ready to mount. The feathers are set in place as they were in the dry skin, and these must be made to change their positions by loosening the bases inside the skin. In most birds, the feathers grow in tracts, and these ridges or tracts are readily seen when the skin is inside out. With the point of a small scraper, the feather tracts are broken up, working first lengthwise and then crosswise of the tract, cutting it into a mass of small squares. These are then picked with the scraper point, separating the base of each feather from its neighbor. The whole inside of the skin is thus gone over wherever any feather butts may be found, until the skin is perfectly pliable and the feathers retain any position in which they may be placed, either erect or lowered. Scraping dry bird skins is a tedious process and actually takes more time, if properly done, than the subsequent mounting.

The wing joints, tail quills, and toes are gently wiggled with the fingers, and again allowed to relax, until these members gradually open to their fullest extent. If one were to attempt to boldly

force open a partially relaxed folded wing at one stroke, the wing would break off short at the joint. It must be manipulated gently and opened gradually. If the scraping and relaxing be not done in one day, the skin may again be covered with the damp cloth and left until the next day. The soaking must not, however, be continued too long, or the skin will rot and the feathers fall out and ruin the specimen.

A dampening box may be used if a number of skins are to be relaxed and mounted, the box being made in the same way as that recommended for holding over fresh skins. The lysol arrests decomposition, and by the use of a dampening box, the feathers are not apt to become so wet. After drying the plumage with acetone and corn meal, the skin is mounted as already described.

Old, dirty mounted birds may be cleaned by the use of acetone, carbon tetrachloride, and benzine, by taking one bunch of feathers after the other, supported underneath by the fingers of one hand while they are sponged with cotton and one or all of the above liquids. In most cases, beating the drying plumage is sufficient to fluff it out, no corn meal nor other absorbent being necessary. Fly specks may be easily removed by rubbing on corn meal wet with acetone, benzine, or both, applied with the fingers, the grit in the meal scouring the feathers.

Finishing.—When the mounted bird has dried thoroughly, all projecting pins or wires are snipped off close and the binding material removed. Small fluffs of wet cotton are placed in the eye cavities with the fine forceps, and from time to time additional drops of water are squeezed from a fluff of wet cotton upon the damp cotton in the eye sockets to keep it wet so as to relax the lids. When partly relaxed, the insides of the lids are scraped with the spoon-shaped end of the small scraper and after again wetting the lids, they soon become as pliable as when fresh, and are ready for the insertion of the glass eyes.

Glass eyes may be purchased from dealers in taxidermists' supplies, and may be ordered from their catalogs, which give the various sizes and colors. Occasionally, a specially colored eye will be required that can not be purchased ready made. In such cases clear flint eyes are used. They are regularly made for the glass eye trade and have only the black center or pupil, the balance of the glass surrounding it being uncolored. By painting on the back

with oil colors, any required combinations of color may be had. After being dried, and covered with a layer of paper before insertion, they are used in the same way as the others.

Black or colored glass bird eyes usually come from the dealer joined in pairs with a piece of wire. This is snipped off close to the glass, and small eyes touched on the back with a little liquid glue and placed in the socket. The eye and the lids are adjusted with a sewing needle set in a wooden handle. If the eye projects too far, which is the most common fault, it is pushed in further with the finger. If too deeply set, the point of the needle is driven through the skin surrounding the eye, and the latter pried out. In "setting" larger eyes, the socket is filled with soft papier mâché, the eye being cleaned off with an artists' brush and water. When dry, the lids are colored with a pen and black ink or other colored paint. A good method of giving a finish to a bird's eye is to coat thinly, with gum arabic or liquid glue, a piece of black cotton thread, and with the aid of forceps and needle, arrange the thread just inside the edge of the eyelid, encircling the eye and cutting off the surplus where the ends meet, the thread going just once around.

If they require it, bills and legs may be colored, using oil colors and turpentine. After painting, wipe off with a soft cloth so the color is left rather as a stain or tint. In some instances, as for example the legs and feet of a yellow-legged hawk, the yellow may be applied evenly all over and allowed to dry. This is followed by a coat of umber, and while fresh this is wiped off, leaving the dark color between the scutes, the scutes themselves coming out yellow. When dry, painted bills or legs should be waxed with beeswax and paraffine dissolved in carbon tetrachloride, painted on hot. In some cases, the oil color may be mixed directly with the wax mixture. By reducing the wax with carbon tetrachloride, it may be painted on as thin as desired, according to the amount of carbon added. If mounted fresh and placed directly upon a permanent perch before the colors of the bill, legs, and other fleshy parts have faded out, it is a good plan to paint them while fresh before they dry and fade. By doing it this way, greater accuracy is attained, all that is then necessary, being to match the natural colors.

In case it is desired to change a mounted bird from one pedestal to another, the feet should be wrapped in wads of wet cotton until the toes are relaxed, so they may be made to conform to another

surface. They are then pinned down and allowed to dry. Permanent perches for a collection of birds may be made by cutting and joining twigs and branches into any desired form. The joints are filled with mâché, and knots, etc., worked out, and colored with oil colors and turpentine. These are preferable to the polished T-perches ordinarily used in museums, and by their use, more spirited attitudes may be worked out in mounted birds.

CHAPTER V

MAMMALS

SMALL MAMMALS

Skinning and Making Research Skins

Under the heading, small mammals, are included animals up to the size of a fox which are usually handled in a different way than animals above this size. For research purposes, large filled skins take up too much storage room and for this reason such skins are usually tanned or fur-dressed. Small mammals are also mounted by a different process than larger ones, the methods of handling small specimens being somewhat similar to those employed in mounting birds as in the preceding chapter.

Like making bird skins, the preparation of study skins of small mammals is very mechanical work. For an illustration of the method usually employed by museum field collectors, we have selected a ground squirrel. For scientific research purposes, it is necessary to measure carefully all mammals before skinning. The measurements are usually recorded in millimeters, but in default of a metric rule, an ordinary two-foot rule may be used and the dimensions recorded in inches and fractions.

But three measurements are essential; these being the total length, length of the tail vertebrae, and that of the hind foot from the heel to the tip of the longest nail.

Total Length.—Lay the relaxed squirrel upon the table resting flat upon its belly and stretch it out to its full extent. Drive a pin into the table at the end of the nose and a second one at the end of the tail vertebrae (not the ends of the hairs), as in Plate VII, Fig. 1. Remove the carcass and measure and record the distance between the points of the pins. Should the tip of the tail be missing, or "bobbed," this fact should be recorded.

Length of Tail.—Grasp the base of the tail and allow the body to hang over the edge of the table, with the base of the back of the tail at the upper corner. Pull slightly upon the tail in order to fit the body snugly to the edge. Drive a pin into the table at the end of the tail bone as before, as in Plate VII, Fig. 2. Remove the squirrel and measure the distance from the upper edge of the table to the pin.

Hind Foot.—This is the distance from the heel to the tip of the longest claw or nail. Bend the foot at a right angle with the leg and hold the heel just at the edge of the table. Flatten the foot by pressure with the finger tip, and drive a pin into the table at the end of the longest claw, as in Plate VII, Fig. 3. Measure and record this distance.

Dividers are usually employed by collectors in measuring small mammals. These measurements, together with the sex, date, locality and name of the collector are recorded in the notebook and, with the field catalog number, also plainly and carefully entered on the label, which is attached to a hind leg of the specimen, just above the heel.

For skinning and “making up” small mammal specimens, a few simple tools and materials are required, as follows:

Scalpels—large and small.

Scissors—large and small.

A small flat file.

Needle and thread.

Tooth brush.

Small cutting pliers.

Steel comb.

Pins.

Galvanized iron or brass wire of different sizes for tails.

Absorbent or other long-fibered cotton.

Alum and arsenic dry, as in poisoning birds.

Acetone.

Dry yellow corn meal.

Fine excelsior.

In an emergency, a small mammal may be skinned with the use of a small pocketknife only, and dry moss, fine grass, or other dry vegetable fiber used for a filling material.

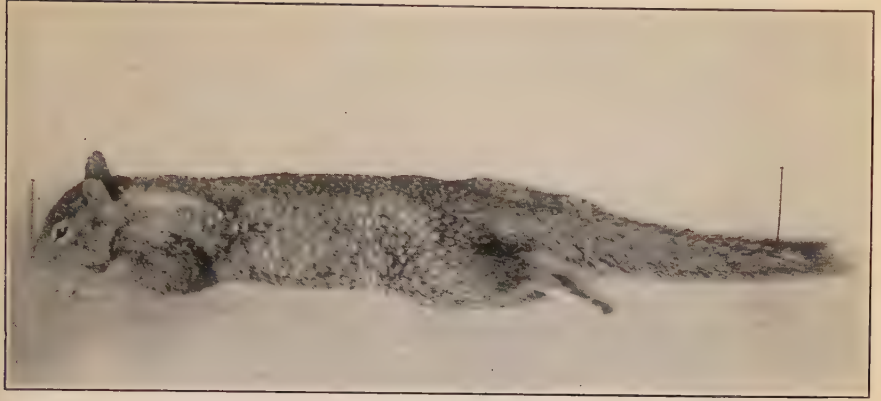


FIG. 1.—Total length.



FIG. 2.—Length of tail.



FIG. 3.—Hind foot.

MEASURING A SMALL MAMMAL

Skinning.—With the point of the scalpel, an incision is made in the skin of the belly from the center of the abdomen to the root of the tail, as in Plate VIII, Fig. 1, being careful not to cut through the belly walls into the abdominal cavity, as this releases blood and liquids which are apt to soil the hair. A pinch of corn meal is sifted into the cut to absorb the moisture, meal being used all through the skinning process, as in skinning birds, to protect the hair and keep it dry. With the thumb and finger, the skin is loosened from the body at the sides of the opening cut, and by forcing the fingers between the skin and the body, the skin is loosened as far around on the back as possible. This exposes the thighs, one of which is drawn up, and by inverting the skin a little, the leg is detached with the scissors, as close to the body as possible. A liberal dose of meal should now be applied, as owing to the severing of the large arteries and veins, blood is apt to flow freely. The leg is inverted or peeled down to the ankle joint, and ordinarily the flesh is now removed from the leg bones, as in skinning birds. This operation is repeated with the other leg.

The skin around the base of the tail is cut and loosened and the fingers worked between the skin and body all the way around on the back to give freedom in stripping the tail. The latter is inverted as far as it will go easily. Holding the root of the tail with the fingers of one hand and the inverted skin of the tail, at the fold, with the fingers of the other hand, by pulling and coaxing, using plenty of dry meal on the fingers to keep them from slipping, all the tail vertebrae slip out of the sheath or skin, as in Plate VIII, Fig. 3.

In mice, chipmunks, and some other small mammals the tail slips out easily, provided it has not been damaged. Sometimes tails are broken in the trap and somewhat dried at the point of injury. Other larger mammals sometimes require considerable work and coaxing to strip the tails. These are best disarticulated close to the body in skinning and the rest of the skinning proceeded with in the usual way, leaving the stripping of the tail until later. Then, if too dry at the point of injury, the tail may be soaked in water. Some tails require working with the point of the scalpel between the skin and the bone after they are inverted as far as they will go. Some mammals, such as skunks and muskrats for example, will not strip. These must be opened along the under side, some-

times in their entire length, and the tail vertebrae removed with the aid of the scalpel. After cleaning and poisoning, the artificial tail is inserted and the skin sewed together.

The skin now peels off easily until the shoulders are reached. Some animals require more or less cutting all through the skinning process to detach the skin from the body, and in others the skin peels readily. The forelegs are detached close to the shoulders, as shown in Plate VIII, Fig. 4, when the skin again peels off until the base of the skull is reached. The bases of the ears are severed close to the skull and the eyes soon appear. Care is now required to avoid cutting the lids. The skinning is continued until the nose is reached. The cartilage is severed, as in Plate XI, Fig. 3, and the skull removed entirely from the skin. In mounting fresh small mammals, it is an advantage to leave the skull attached at the extreme ends of the upper and lower jaws, as shown in Plate XI, Fig. 3, the skull being disarticulated from the body and cleaned as usual. The legs are inverted as far as the wrists and ankles, if this has not been done in skinning the body, and the flesh and tendons removed from the bones, leaving the latter all attached at their joints. Mice and shrews ordinarily do not need to be skinned down any farther, but an animal of the size of a ground squirrel should be skinned as far as the toes, as in Plate IX, Fig. 1.

In some animals, like the skunk and muskrat, which have a plump, fleshy foot, it is necessary to make a longitudinal cut in the sole of the foot before the latter can be inverted and properly cleaned. In dry climates, collectors ordinarily do not skin down on the feet of small mammals any farther than is actually necessary to keep the foot from decomposing. Many collectors slight these members sadly. When dry, the feet of a small mammal that have not been properly skinned and cleaned may be all right, but if the skin is relaxed at any future time for mounting, the hair and epidermis of the feet are bound to slip and ruin the specimen for a perfect mount.

The late J. H. Batty once informed me that the only way he could preserve the feet of squirrel monkeys collected in a humid tropical district, was to encircle each toe clear to the nail with a flattened wire set in a wooden handle, thus separating the skin from the bones and allowing the former to dry out. Alum, arsenic and dry sawdust were then rubbed into the flesh side of the skins



FIG. 1.—The opening cut.



FIG. 2.—One leg disarticulated.



3.—Both hind legs severed and the tail stripped.

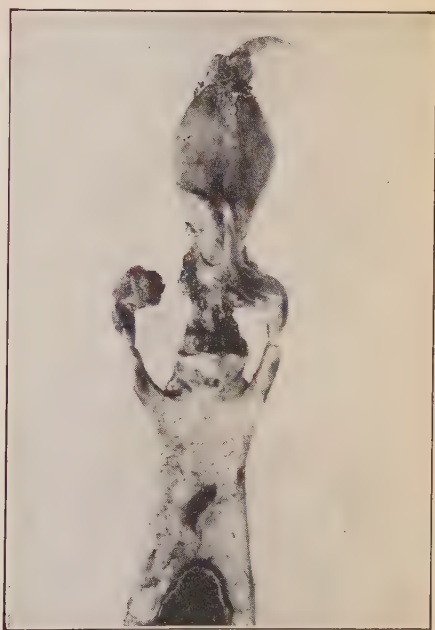


FIG. 4.—The body skinned and one fore leg disarticulated.

SKINNING A SQUIRREL

the sawdust absorbing the moisture and assisting in drying the skin.

If it be known beforehand that one or more of a series of study skins will later be used for mounting, it is a good plan to give special attention to these in the field and to indicate in the field catalog the specimens that have been treated with this object in view. Such a procedure would save trouble when the skins were relaxed for mounting and give more perfect results.

As the entire skull is desired, either for mounting or for study, this is severed from the body, care being taken not to injure the bones of the base. After lightly encircling the neck with the scalpel and cutting through the flesh, the skull may be twisted off the neck vertebrae, this being safer than cutting all the way through with the knife and possibly damaging the base of the skull. With the scalpel, clean the skull roughly of the flesh and remove the tongue and eyes. Very small skulls, like mice and shrews, are extremely delicate, and in cleaning, the *zygomas*, or slender cheek bones arching just below the eyes, are apt to be snapped off. Such skulls should not be cleaned of flesh, but should simply have the eyes and tongue removed. The brain should always be removed by the use of a small flat-ended hooked wire or a small scraper, and rinsed or stringed out with water. If it is desired to have the skulls perfectly white when cleaned later, they may be soaked in cold water for an hour to remove the blood. Alum or formalin should not be used on skulls or skeletons that are to be used for study purposes, as these retard the softening of the flesh in the future operations of cleaning. If dry skulls are attacked by insects, they may be dipped in strong arsenic water, or the dry powder may be sifted on them. For study purposes, skulls should never be cut or mutilated in any way nor the base opening be enlarged. After cleaning, the skull is labeled with the catalog number of the specimen, the sex, and the initials of the collector, and placed in a box or strung on a thread or cord through the label loops and hung up in the shade to dry.

The inside of the skin is next thoroughly cleaned of all flesh and fat. Mice and animals that are not fat seldom require much cleaning, but to remove the fat from a fat ground squirrel skin is quite a task. This may be done with a knife alone, using liberal quantities of dry corn meal to absorb the oil. But a quicker and better process is to use, on a small scale, the methods of the large

mammal preparator. A piece of three-eighths-inch tubing or rod about eight inches long is covered with a piece of rubber hose that fits snugly, allowing a couple of inches of the tubing to project beyond one end of the hose. A hole is bored into the edge of the table and the tubing inserted, fitting the hole loosely so it will revolve easily. This "beam," as it is called, projects from the table horizontally toward the operator. The skin is placed over the beam, flesh side out, and with a sharp knife and a sharp-toothed hack saw blade, six inches long, set in a slot sawed in the edge of a flat wooden handle, like a lath, the skin is scraped and the fat and flesh quickly removed. The fingers may be substituted for the beam in scraping the legs as these are too small to stretch over the beam. Larger skins and thin delicate ones like foxes' may be quickly and safely beamed by inserting and wedging a fine-toothed hack saw blade in a slot sawed in a long wooden handle, after the manner of the currier's knife used in beaming large hides, the upright beam then being used instead of the horizontal.

The skin having been thoroughly cleaned of all flesh and fat, it is turned right side out and examined for blood spots. Should any exist, these are removed as in cleaning feathers. A fine-toothed steel comb is also useful in breaking up blood clots and straightening out the hair. The skin is then poisoned by dusting the inside with alum and arsenic, dry, as with birds, and when turned right side out is ready for filling. If it is desired to keep the skin fresh for a few days, or to mail it, after poisoning it may be placed in a small tight box containing wet cotton and a little lysol, as with birds.

"Making Up" a Small Mammal Skin.—"Made up," or filled, skins of small mammals, like bird skins, are designed chiefly for study or comparison and are shaped so as to occupy as little space as possible and at the same time show all parts of the specimen. Museums all over the world now have all small mammal skins prepared in this manner. A large series of each species is secured whenever possible to show variation in sex and age and these are used in comparison with series of specimens from other localities in order to properly classify them.

The leg bones are wrapped with cotton and turned right side out again, as in Plate IX, Fig. 2. It is best to wrap each leg separately and turn it right side out, doing the front legs first,



FIG. 1.—The skin inside out, ready to be poisoned, and the skull cleaned.

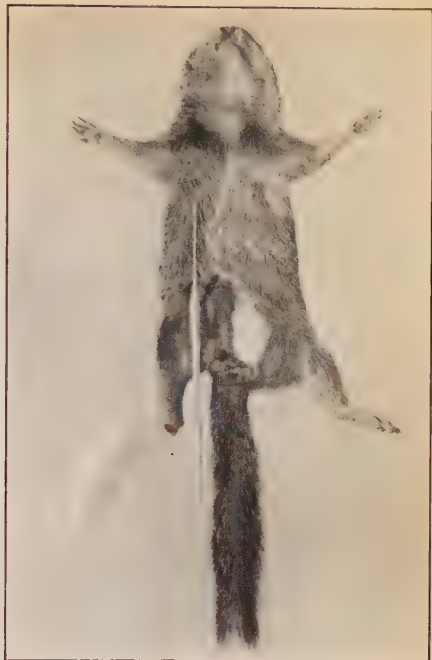


FIG. 2.—The skin nearly ready to be filled.

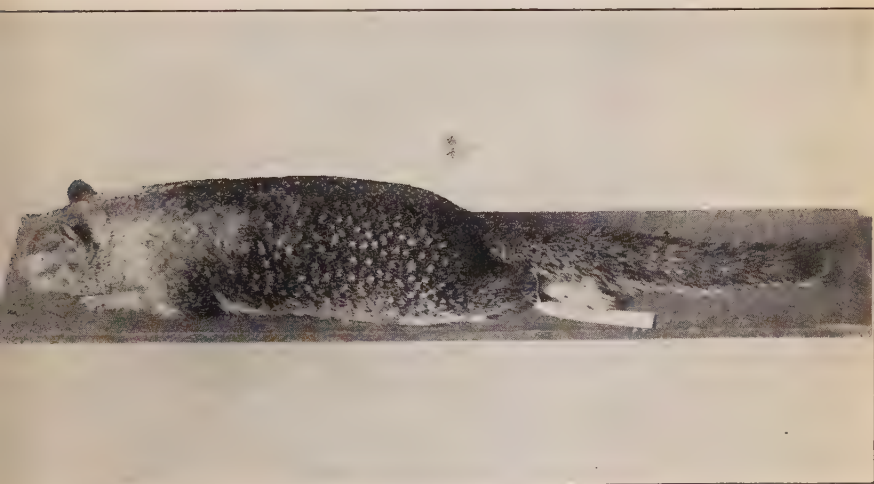


FIG. 3.—The completed skin.

"MAKING UP" A SQUIRREL SKIN

rather than wrap them all and then turn them, as the skin in small mice, etc., sometimes dries rapidly when inverted.

In order to keep the tail from being broken in handling, later, when the specimen is dry, a wire, neatly wrapped with dry cotton, is inserted. It is essential that the wire extend to the extreme tip of the skin of the tail, otherwise the portion beyond the wire when dry, is even more liable to be broken than if no wire were used at all. To reach the extreme tip, it is necessary to file the end of the galvanized, or what is better, brass, wire and taper it to a point. The wire should reach from the tip of the tail up about one-third the length of the body to give the tail a firm support. In order to fill out the tail sheath properly, the wire, after being tapered, is wrapped with a long fluff of absorbent cotton by twirling the wire between the thumb and finger of one hand and feeding in the cotton with the other, making it assume somewhat the proportions and shape of the natural tail which was withdrawn. Considerable practice is necessary to wind a smooth tapering tail quickly. Wetting the cotton after it is wrapped on the wire and rolling it flat on the table with the side of a rule or a flat stick will smooth it. Very smooth tails may be made by dipping the cotton-wrapped tail in hot paraffine or painting on a little dilute Le Page's blue and then rolling it. Wet the wrapped tail, dust it with the very arsenic and work it down into the tail sheath, fitting the point snugly to the very tip. A quantity of tails of different sizes may be made up at leisure moments or before going into the field and thus save the time necessary to prepare them at the time when needed.

With needle and thread, take a stitch through the front of the lips to hold the mouth shut. The legs and tail having been filled, nothing now remains to be done but to fill the skin of the body and head.

A roll of cotton about the length and girth of the natural head and body is compressed and grasped firmly with the long forceps, lengthwise of the roll, with the tips of the forceps almost at the upper end of the cotton roll. This is inserted into the skin through the belly opening, keeping a firm grasp on the forceps, and working the skin down upon the cotton, the skin of the nose resting against the upper end. After adjusting the front legs and determining that the skin is properly placed on the cotton and not too long nor

stretched out, the forceps are withdrawn, when the cotton fluffs out, filling the whole interior fully and evenly. If the filling be introduced in the form of balls or pads, a lumpy exterior will result. If done properly and just the precise quantity used, the roll of cotton should fill the whole interior of the skin nicely and no additional cotton will be necessary. Long-fibered absorbent cotton works nicely on mice and mammals of the size of a chipmunk or rat. Larger animal skins may be filled with tow or fine excelsior. The latter are preferable to cotton in large masses as the air circulates more freely through them and permits the skin to dry out more rapidly.

The ends of the bones of the hind legs and the wire projecting from the base of the tail should lie on the top of the cotton filling as the squirrel rests upon its back. These are covered with a fluff of cotton to keep them from coming in contact with the skin. The belly opening is neatly sewn together with needle and thread. In sewing allow the needle to pass from the inside of the skin out through the fur. If reversed, when the thread is drawn through the needle hole, the surrounding fur will be drawn in with it, and ball up and bind and tear the skin.

The skin is now turned over upon its stomach and shaped and compressed with the hands until it assumes the general form of the squirrel skin shown in Plate IX, Fig. 3. Care should be used not to have the skin too full nor bulging. It should be made the same approximate length as the total length measurement made before skinning. After slightly brushing the hair with the toothbrush the label is firmly attached and the specimen pinned upon a soft wood board by driving a pin down through each foot into the wood to hold them in place while drying. If traveling much of the time while collecting, it is a good plan to take along a box of suitable size equipped with thin soft-wood trays of different heights. The specimens may then be pinned down in the trays and when convenient these may be taken out and exposed to the air to dry the skins. These should never be dried in the sun, as uneven drying produces undue shrinkage and generally results in badly distorted specimens. The ears of some specimens may be supported while drying by twisting a small fluff of cotton around a pin and working the point of the pin into the ear opening. This leaves a small body of cotton inside the ear to keep it from wilting and drying flat on

storted. The nose and eyes may be further perfected and adjusted with the small forceps, and additional pads or fluffs of cotton introduced if necessary.

Bats are treated in the same general way, with the additional measurement of "extent of wings," this being the distance from base to tip of the outstretched wings. Bats are better opened on the back instead of on the belly in skinning, and when made up, the specimen is placed upon its back with the wings partly closed. If left extended, they take up unnecessary room and are also liable to be broken in handling, for the dry wings of bats are very brittle.

Weasels, having a long, slender body, are rather difficult to fill the ordinary way and to keep in the proper proportions. They are better filled with a roll of tow or excelsior smoothly wound with thread to the dimensions of the head and body. The head portion is covered with a flat wad of loose cotton and the whole is inserted inside the skin, in place of the loose filling. The body end of the wire is sharpened and forced up into the wound body. Rabbits, having a very thin, tender skin, require a stiff wire in each leg to support it and also to keep it from being broken off in handling when the skin is dry. With thread, securely bind a piece of stiff wire to the upper leg bone, then wrap with cotton and fill the body as usual. The wire extending back from the front leg is lashed first with thread to the wire running forward from the hind leg on the same side, the connecting wires lying parallel with the body and being covered with a layer of loose filling. These wires hold the legs rigidly, and keep them from hanging down when the dry skin is lifted up in handling.

Some collectors recommend placing wires in the legs and feet of all small mammals, even mice, to prevent the feet from breaking when dry. Leaving in the entire leg bones, as described, lengthens the legs sufficiently for ordinary use without wires. In order to save the time necessary to remove the flesh from the leg bones, collectors have been known to boldly snip off the bones close to the feet. This leaves these members attached only by the skin on the legs, and as the wrists and ankles of small dry mammal skins soon become very brittle, such skins should be reinforced with sharpened wires reaching down into the foot. These may be introduced from the inside of the skin and wrapped with cotton before fixation. When the bones are accidentally broken at these points,

they should thus be replaced with wires; especially the hind legs which are more apt to be broken in handling, as they carry the labels. Placing wires in the legs of study skins unquestionably strengthens them but, if reasonable care be used in handling them when dry, it is scarcely necessary to take the precaution and the slight advantage hardly warrants the expenditure of the extra time taken in the preparation of the specimen.

Mounting and Finishing

The successful mounting of small mammals is much more difficult than that of birds. Many people have attained the top notch in bird work, but comparatively few have given small mammals the study and attention necessary to the production of the same standard of work that has been reached in bird taxidermy. It is a rare thing to see a well-mounted small mammal collection in regular museum exhibits, most of the specimens being ill-shaped and lifeless. To reach perfection in mounting mammals, either large or small, necessitates close study of the living animal and the same readiness to copy form and attitude that is required in bird mounting.

In skinning small mammals for mounting the skinning is performed in the same way as already described until the nose is reached. As already indicated, instead of detaching the skull entirely from the skin, it is left attached by the ends of the lips, as shown in Plate XI, Fig. 3. Be careful to skin entirely over the nose as shown in the plate. If this detail be neglected, and the nose be not properly skinned and the central cartilage between the nostrils removed and the space filled with mâché, it will shrink badly in drying. The lips are also split from the inside and afterwards filled with mâché, or potters' clay mixed with dilute gum arabic, to hold them in place and keep them from shrinking. It is not actually necessary to have the skull attached to the skin by the front of the lips, but it is much easier afterwards to model the mouth into its proper shape than if the skull be entirely freed.

To keep the whiskers separated so they will stand out, instead of drying down flat against the cheeks, the bases of the whiskers inside the skin must be separated with the scalpel and scraper point in the same way as scraping the insides of feather tracts in relaxing

dry bird skins. The inside of the skin of the head, including the inverted ears, may then be painted with the glue-glycerine solution.

For mounting, the ears of small mammals should always be inverted clear to the tips and edges, by working inside them with the small scraper and a flat-ended wire with the edge filed smooth and round, the cartilage being left in. The insides of the ears are then dusted with dry arsenic and painted with warm water, glycerine and glue, mixed. This keeps the cartilage of the ears of mice, squirrels, rabbits, etc., from shriveling. When the specimen is mounted, warm wax softened by adding linseed oil and rosin, and containing a little red color, is injected with a warm syringe into the ear through the ear opening and modeled into shape. The glue-glycerine composition makes the skin and cartilage transparent, and pink silk threads, waxed and flattened, may be placed inside the ears of rabbits to represent blood vessels. The whole ear may be made pink before the glycerine solution is applied, by painting the inside with pink water color or water dye. Red ink, reduced with water, will answer.

One of the chief difficulties in the mounting of small mammals lies in the shrinkage of the toes in drying. In animals the size of a squirrel, the toe bones should be encircled clear to the nails with a flat-ended steel wire set in a wooden handle, and each toe injected with soft warm mâché or wax, or clay and gum arabic, as in mounting fleshy-footed birds. This, of course, takes time, but if the finest results are to be attained, time should not be considered. The feet of very small subjects may be soaked in warm glycerine solution for a few hours to plump them and stop shriveling.

Before removing the flesh from the leg bones, lay the legs flat upon a piece of paper and trace around them with a pencil. These tracings afterwards serve as guides in making up the legs. It is necessary to use all the leg bones in mounting. If any are broken, they should be mended by splicing and restoring them with splints of wood.

Various methods of mounting small mammals are in use. One consists in constructing a hard-wound body of excelsior and thread, as in mounting birds. Another method, and the one that has been most commonly used for many years, is to introduce supporting wires and fill out the body skin by stuffing it with soft filling. Still another way is to make a combination of the two and use a hard-

wound round or flattened ball for the rear half of the body and introduce this after the front half has been filled with loose materials, the supporting wires being clinched in the hard body.

Mounting.—As an illustration of the soft-filling method, we have selected a ground squirrel.

The toes having been skinned, or the bones encircled, clear to the nails and injected with warm wax to reduce the shrinkage in drying; the ears having been inverted, and the nose and lips carefully split from the inside; the skin is ready to mount. Six soft iron wires are cut, in this case number 18 wire being used, as this is heavy enough to support the head or legs firmly in any position in which they may be placed. Four of these wires are for the legs and they are all sharpened on one end with a flat file. When a small mammal is to be mounted as sitting erect, in which case the forelegs do not support the body, smaller wires may be used in the front than in the hind legs, as the smaller the wire the easier it is to manipulate in the mounting process. The fifth wire is for the head and body, and the other, tapered to a long point, is for the tail. A glance at the illustrations will give an idea of the respective lengths of these wires. It is better to have the wires longer than necessary, and snip off the excess in assembling.

The pointed end of one of the leg wires is introduced through the sole of the foot, running along the inside of the calcaneum, or heel bone, and up beyond the end of the femur in the hind leg, or the humerus in the front leg, allowing it to project several inches and turning it over into a long hook so it will be less in the way, as shown in Plate X, Fig. 1. The wire is lashed fast to the leg bones in their entire length with strong thread.

All the leg wires having been made fast, the muscles are replaced by winding or wrapping with soft, damp excelsior or tow, using thread for binding. With the pencil tracings as a guide, each leg is carefully made up by selecting smooth wisps or pads of the filling material, drawing them through the fingers to straighten the fibers, and binding them down with thread. A wound foreleg is shown in Plate X, Fig. 1. All four legs are similarly treated. For mice and very small mammals, excelsior or tow are too coarse, and absorbent cotton is used instead, the cotton being simply twirled around the leg bones, as in making study skins, after the wires are made fast.



FIG. 1.—Wiring and leg making



FIG. 2.—The skin right side out and ready to be coupled.

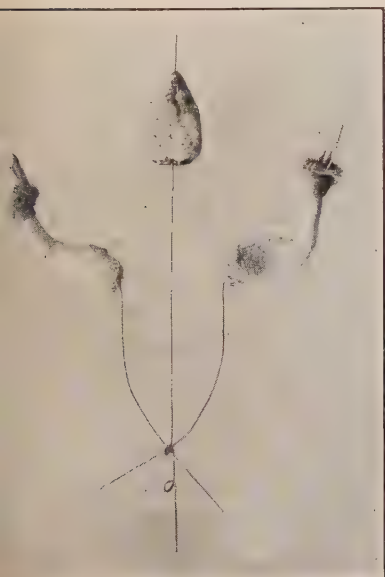


FIG. 3.—Coupling the front legs.



FIG. 4.—Coupling the hind legs and tail.

MOUNTING A SQUIRREL

and or body wire is now taken up and, with a pair of pliers, two loops or rings are formed near one end, as shown in Plate X, Fig. 3. The other pointed end of the body wire is forced through the back of the skull and out through the nose, the skull slipping easily up or down the wire. The skull is covered with stiff papier-mâché, and the muscles built out or restored. The inside of the skin having been well poisoned, it is now turned right side out over the skull, with the pointed end of the body wire projecting from one of the nostrils. The forelegs are coated with soft mâché and turned right side out, the mâché offering a slippery surface for the skin to rest upon and thus assisting in the turning process. The hind legs are coated with mâché and turned as in the forelegs.

The tail wire is now wrapped smoothly with cotton to the general size and proportions of the tail bone that was withdrawn in skinning, and the artificial tail dipped in hot wax, paraffine, glue, or Le Page's liquid glue and rolled upon the table to smooth it. One of the chief beauties of a squirrel lies in the fluffy tail, and this be allowed to shrink in drying so the loose appearance of the hairs is gone and the circumference reduced to one half the natural size, as is usually seen in mounted squirrels, one of the strongest characters is lost. To obviate this shrinkage, the wax or glue coated tail is liberally painted with the glue-glycerine composition, dusted lightly with dry arsenic, and inserted into the tail sheath. While the specimen is drying, if the hair of the tail be occasionally puffed out with the fingers, the tail will ultimately dry as full and fluffy as in life.

The tail having been attended to, the wires projecting from the sides of the legs are straightened, the front leg wires pointing backward and the hind leg wires projecting forward inside the skin, when the specimen appears as in Plate X, Fig. 2, ready for coupling.

It is a good plan in the soft filling process, as soon as a wire is inserted, to snip off the sharp point as it is apt to prick the hands during these operations. If the full hard-wound body is to be used, the central wire, without the loops, is introduced while the body being made, the anterior projecting end passing through the skull the same way as already described, the front legs, then the hind

legs, and lastly the tail, being clinched in the body as in mounting birds.

If the intermediate, or combination hard-body and soft-filling, method is to be used, the neck wire and the front legs are clinched in the body after the fore parts have been filled as later described. The hind legs and tail are then coupled as usual. In any event, the front legs are first coupled, then the hind legs, and finally the tail. But as the coupling of the front legs interferes somewhat with the insertion of the loose filling, this is first put in as follows: Fine excelsior or tow is cut up fine with a pair of shears. This may also be done with a sharp hatchet and chopping block. With the long forceps, the chopped material is taken up in loose bunches and introduced into the skin through the belly opening, filling the neck first and working back toward the opening. A "pusher," made by flattening the end of a stiff piece of wire, filing a notch in it and setting the other end into a round wooden handle, is also used in combination with the forceps to fill and arrange the stuffing.

When the neck and fore part of the body are fully and evenly filled out, the ends of the foreleg wires are passed through the first loop in the central wire, as in Plate X, Fig. 3. The wires at this point are grasped firmly with a pair of flat pliers, and with a second pair of flat pliers, the ends of the two leg wires are twisted tightly together just beyond the loop. One of the wires is cut off just beyond the twist, and the remaining end twisted around the central wire as in Plate X, Fig. 4. This holds the front legs firmly. The balance of the body is now stuffed, leaving the last loop of the central wire exposed on the upper surface of the filling. The hind legs are coupled in the same way as the forelegs, as in Fig. 4 of the same plate. With thin wire, the projecting ends of the central and the tail wires are bound together, where they overlap, and the coupling is finished. The body filling is now completed and the opening cut sewed up. To keep the skin from shifting upon the skull, a pin is driven through the skin into the skull at the anterior corner of each eye.

A suitable pedestal is selected and the attitude of the specimen determined upon. The pose and positions of the feet are worked out by bending and forcing them wherever desired. With the hand drill, holes are bored into the pedestal for the reception of the supporting wires projecting from the bottoms of the feet. The squir-



FIG. 1.—Mounted squirrel, with the skin of one side cut away to expose the interior mechanism.



FIG. 2.—The completed specimen.



FIG. 3.—Squirrel's head skinned for mounting.

THE COMPLETED SQUIRREL

el is placed upon the pedestal and the artistic part of the operation commences.

As with birds, up to this point the operations have been almost purely mechanical, but from now on until the finishing touches are given, the opportunity is presented for the preparator to exhibit his knowledge of the form and appearance of a ground squirrel. The legs are bent and compressed into shape with the hands, and the squirrel taken off the pedestal and put back on, as often as is required. The head and tail are bent into shape, and certain parts depressed with the fingers. Any parts that require more filling are plumped out by thrusting a long sharp awl through the skin deep into the filling material and prying out the latter. The pusher and forceps are also used to shift the filling, working through the belly opening when the specimen is off the pedestal. If necessary to reach certain parts of the interior, a small slit may be made in the skin just back of the foreleg, the filling changed or more added, and the slit afterwards sewed up.

The wire projecting from the nostril is snipped off short so it slips inside the skin and disappears. Papier-mâché, or clay mixed with dilute gum arabic, is introduced through the mouth with the small scraper to model the lips and nose. The ears are injected with soft warm wax, and pinched and modeled into shape. The eyes are "set" by filling the sockets with soft mâché and inserting glass eyes as with birds, finishing with an artist's brush and a little dry lampblack mixed on a piece of tin or glass with the wet brush. Any excess of black may be removed by agitating the brush in water and painting the eye with the clean, wet brush. The hair is arranged with a tooth brush and steel comb. The appearance of long-haired mounted small mammals may be entirely changed according to the way in which the hair be arranged, so this should be carefully done. Another detail that is commonly neglected, and one which, if not properly done, detracts very much from the lifelike appearance of a mounted small mammal, is the correct arrangement of the toes. These should be pinned in natural positions until dry. The finishing and waxing of open mouths is done in the same general way as with large mammals.

Another quicker and easier method of soft filling is to arrange the wires as already described and couple them all, before any filling is introduced. Dry cork dust, or fine sawdust, is mixed with

liquid shellac and stirred together in a bowl, just enough shellac being added to dampen the cork. With a spoon, the damp mixture is ladled into the skin and shaken, then tamped with a flat-ended ramrod until completely full, the skin being suspended head down during the process. A funnel soldered to the end of a piece of tubing with a large-headed wooden ramrod loosely fitting the inside of the tubing, makes an excellent implement with which to inject the cork and shellac mixture. The tubing may be forced through the soft cork filling to any desired point and more filling forced in with the ramrod. Wads of tow may also be worked through the cork filling from the belly opening and forced with the pusher or forceps into any portion of the interior. Excellent results may be obtained by the use of this method on small mammals, as the cork and shellac mixture, under the skin, may be easily compressed and modeled into any desired form. When dry, the specimen is very smooth, and as the shellac dries out, it leaves the specimen firm and hard all over.

Rabbits, having a very thin, tender skin, are not amenable to soft filling methods. They are best mounted by winding a hard excelsior body of the proper size and form and coupling the legs to it, as in mounting birds. In winding the body, it is a good plan to make it before the leg wires are inserted, so the skin may be fitted to the body to test it for form and size without the interference of the leg wires. The skin is fitted to the body and the latter taken out and corrected an indefinite number of times, until the proper size and form are assured. After coupling, a little loose filling may be inserted anywhere, between the skin and the body. Weasels, being long and slim, are difficult to "shorten up" by soft filling, and are also best mounted with a hard-wound body, as recommended for hares and rabbits. Foxes are also easily mounted by the hard body method, the body being finally coated all over with soft *mâché* to give smoothness, and when dry coated with paste or thin *mâché* and inserted into the skin, as in mounting large mammals.

The third, or intermediate method, is the use of a hard wound excelsior ball, somewhat flattened laterally, and made to fit snugly into the rear half of the body skin, and having a protruding neck wire as in mounting birds. The head, legs, and tail are then treated as usual. The front half of the skin is filled full of cork and shellac mixture, and the pointed neck wire worked up through

and out through the nostril, the hard body damming the cork lining and keeping it from coming out. The front legs are then coupled by clinching the wires in the body. The hind legs are coupled, and lastly the tail, when the belly opening is sewed together and the specimen posed and placed upon the pedestal. This method produces a good, firm specimen and, for a squirrel represented as sitting up, is better than any of the other methods described. The soft modeling material is only in the fore part of the body and the neck, where it is needed, and the rear part, by reason of the hard body, does not sag nor alter its form in hanging. For all-around work on small mammals, this is perhaps the best and simplest, but the work is not quite so quickly performed with the entire cork and shellac loose-filling process.

LARGE MAMMALS

The Treatment of Skins

Measuring Large Mammals.—Animals larger than a fox, or even smaller if they be short-haired, are generally mounted by constructing a life-sized model, or "manikin," upon which the skin is glued and sewed. For the purpose of mounting, but few measurements of large mammals are necessary. In building a box the essential measurements are length, width, and height; and girth measurements for making a model are just as useless as they would be in constructing a box or in modeling a round ball of a stated diameter. The time when the measurements are most needed is when the framework for the model is being constructed, when they must be used in straight lines between fixed points.

The measurements actually necessary to build a properly proportioned manikin are five in number, taken from the dead animal as it lies flat upon the ground, with the tape stretched tightly from point to point, and not allowed to sag nor follow the contour of the body.

1. Total Length.—This is the distance in a straight line from the end of the nose to the base of the tail.
2. Femur to Humerus.—Head of the femur to head of the humerus, from center to center of the bones.
3. Body Depth.—From the top of the back to the brisket, just behind the elbow.

4. Chest Width.—Across the chest, from the outsides of the heads of the humeri.

5. Eye to Humerus.—It it be known beforehand just what position the head is to occupy in the mounted specimen, it is a good plan to place the head in that position and take the measurement accordingly, as the distance from the eye to the head of the humerus varies according to the position of the head, as it is raised or lowered. In raising or lowering, the head does not describe an arc with reference to the humerus, but rather with the spinal column of the base of the neck, which is some distance above the humerus. The usual method of measuring the neck length is to stretch the head and neck out straight and make the measurement. Then in mounting, if the head be raised, the distance between the head of the humerus and the spinal column must be estimated, and this distance added to the field measurement made with the head outstretched, as the raised head is farther from the head of the humerus than when lowered.

The depth of the neck just behind the skull and the depth of the neck where it joins the body are helpful in mounting, but not essential.

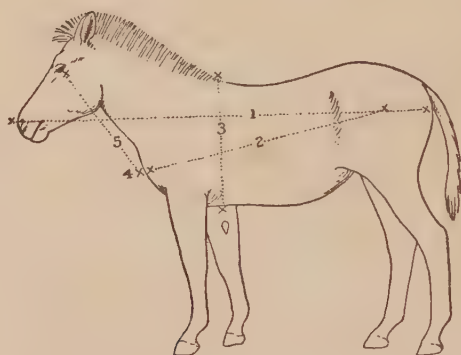


FIG. 1.—MEASUREMENTS OF A LARGE MAMMAL.

Skinning.—The method by which a large mammal is to be mounted will, in a general way, determine the opening cuts in skinning. If the animal be long-haired, like a bear, the skin is usually opened from the brisket along the median line of the belly to the tip of the tail. Then up the back of each leg, from the bottom of the foot, over the center of the large tendon in the hind leg and the elbow in the front leg, the cuts continuing on up and intersect-



from photograph by Leslie Simson.

FIG. 1.—N'dolo drying skins for the Simson African collection.

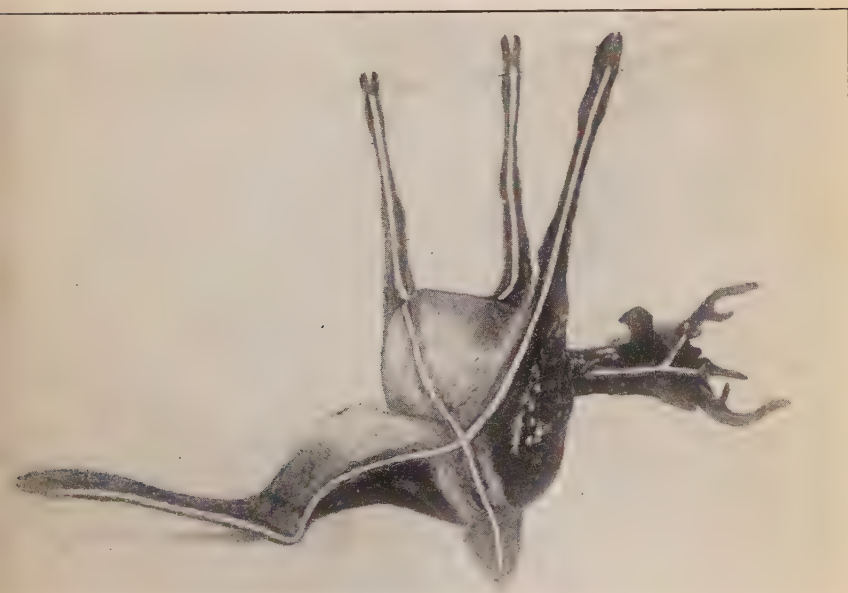


FIG. 2.—Opening cuts in skinning for a flat skin.

SKINNING AND DRYING LARGE SKINS IN THE FIELD

g the central or belly cut, as in Plate XII, Fig. 2. If the animal has horns, a Y-shaped cut must be made on the back of the head, as shown in the same figure. This makes a flat skin with the exception of the neck and head. This is best if the skin is to be salted. But for a long-haired skin which is to be dried without salt, in order that the neck and head may dry out quicker, the neck may be opened from between the jaws on down the throat and joining the brisket cut, thus opening the whole skin flat and allowing the air to strike both sides. Never cut through the lower lips if possible and avoid it. This cut may, of course, be sewed up, but more or less patching and "hair setting" is generally necessary in finishing, to conceal the cut, owing to the usual shortness of the hair of the lower lip. Hairless animals, such as hippos, rhinos, and small elephants may be opened flat in this way, as it is an easy matter to conceal the seams when dry with papier-mâché, wax, and paint. The skin of a large elephant is too heavy to handle in one piece. These are usually cut into three pieces, the head and neck being one piece, and each side or half of the body with the legs of each side attached, making the other two. In seals or sea lions, the belly opening should not extend forward any further than the opening cut extending across the breast from the rear sides of the bottoms of the front flippers. In other words, do not cut up the under side of the body any further than is absolutely necessary to skin the animal.

The front of monkeys and apes, or a bear which is to be mounted standing erect, is generally the show side, and as the hair on the breast and belly is thin so the skin shows through, the opening cuts are best made on the back of the animal, from the neck to the pelvis. The under side of the tail is opened as usual, but it is not necessary for this cut to connect with the one on the back. The bottoms of the feet and the toes are opened in large monkeys. For small monkeys and marmosets, the bottom of the foot may be opened, but instead of opening each slender toe, it is better to separate the skin from the bone, clear the nails, and completely encircle the bone by working through the foot opening with a small flattened and rounded wire set in a wooden handle, like a small screw driver. In mounting, the toes are filled with soft papier-mâché or soft wax, injected with a long slender-nosed syringe, the contents being kept warm by immersing the filled

syringe in hot water. This should also be done with other small animals whenever possible, as without this precaution the toes shrink badly in drying. Larger clawed mammals, such as wild cats, 'coons, foxes, coyotes, bears, and lions, may be skinned to the toe nails with a knife without opening the bottom of each toe. This is by far the best and easiest way to do it, the encircling method being used only when the toes are too small to be inverted.

Short-haired animals, such as African antelope and gazelles, horses, zebras, and deer in short coat, should never be opened up the legs nor under the throat, unless absolutely necessary, as it is next to impossible to conceal the seams. The opening cut in such animals should reach from the brisket along the center of the belly to the tip of the under side of the tail. If the animal has horns, the usual Y-shaped opening at the back of the head and neck is necessary. The back of each foot must be opened up to a point between or just a little above the dew claws, or accessory hoofs. In skinning, the foot is disjoined at the junction of the first phalanges with the leg bone. The legs are disarticulated at the pelvis and shoulder blades, and the legs turned inside out, or inverted, as in skinning small mammals. The legs will skin easily until the knees and hocks are passed, in the ungulates. To loosen the skin from the shin, or shank bone, an instrument called a "leg iron," like a long-shanked screw driver, is used. This is sharpened and a V filed in the end. The insides of the V are kept sharp, and the outer edges slightly rounded so as not to tear the skin. By pushing this through the openings at the bottoms of the feet after they are disjoined, between the skin and the bone, the tendons and fibers connecting the two slip into the V and are cut. In this way the bone is completely encircled and the skin loosened. By pulling on the bone and holding fast to the disjoined foot at the same time with the other hand, the leg bone is slipped out. The feet are then skinned as usual.

In salting closed legs, a few handfuls of dry salt are poured into the skin at the upper end of the inside of the leg and forced and worked down to the feet with a smooth round stick used as a ramrod. When the skin is afterward hung up to dry, in order to allow the air to circulate freely and dry out the legs, the stick is run back and forth through the leg and the excess of damp salt forced and shaken out. All the African big-game mammals col-



FIG. 1.—The ear inverted



FIG. 2.—The cartilage half out.
SKINNING THE EAR OF A DEER

ted by Mr. Leslie Simson were skinned in this way; and the specimens when mounted had clean, smooth legs without any visible seams.

As already described, the ears of most small or large mammals could be skinned and inverted, or turned inside out, in order to allow the salt to strike the hair roots and also to permit the ear to dry properly, as shown in Plate XIII, Fig. 1. In dry climates ears will sometimes dry without inverting and later relax and invert without slipping. But it is harder work to turn an ear which is thus dried, and in many instances more or less of the hair is ultimately lost. Ears of large mammals should, therefore, always be skinned, while fresh, clear to the tips and edges, using a mallet and large scraper for the purpose. Later, in mounting, the cartilage is taken out altogether, as shown in Fig. 2 of the same plate, and replaced with an artificial cartilage, as later described.

In mounting large mammals, the bones necessary are the entire skull, pelvis, and full leg bones with the exception of the scapulae, and shoulder blades. For convenience in handling in transportation, large-horned skulls may be sawed in two laterally. Afterwards in mounting, the two halves are bolted together. If the bones are missing in whole or part, duplicates over which to model must be provided. If one hind leg and one front leg only are available, it is a simple matter to use these as guides for length and form, and make wooden substitutes for the missing ones. If no bones nor measurements of them have been saved, bones of another individual of the same size and kind may be used. If these are not available, as for instance when large animals like the musk ox are collected in the far north and the difficulties are too great to bring out more than the skin and the skull—wooden bones must be roughly carved out of wood, drilled at the joints and wired together, the wiring allowing for freedom of motion at the joints. In such a case, the skin must first be relaxed and beamed and the bones made to fit the skin. The framework may then be constructed as afterwards described and the skin fitted to it to try it out for size and general form, after which the skin may be allowed to dry out and the manikin made as usual. If the bones have been saved but are wanted for a separate exhibit as a skeleton, they may be used in preparing a clay model and the casting method used to construct a manikin, as later described, in which case the bones may after-

ward be saved for any desired purpose. Or wooden duplicates may be made, or the bones may be cast in wood and plaster by the use of the clay mould as outlined in the chapter on Casting, and the direct mounting process used.

Small mammals, like birds, should be mounted while fresh, if possible. But when this can not be done, as for instance on a distant field collecting trip, it is a good plan to prepare for future mounting, as before stated, a few typical specimens of each species taken. Particular attention should be given to the feet, nose, and ears, the latter being skinned and inverted clear to the tips, as already described. Tails should be filled with a soft brass wire, filed to a point at the tip, and wrapped with cotton or tow. If the unopened or stripped tail sheath of mice, squirrels, etc., be not filled when fresh, the skin collapses and dries fast one side to the other, and it is sometimes impossible to again separate the skin, and insert a wire to the tip. The skin should then be moistened inside if at all dry, rubbed with table salt, and dusted over with dry arsenic. The skin may then be folded flat and dried, or it may be filled in the usual way of preparing a study skin and marked on the label, "for mounting." A skin that has been salted and dried in a temperate climate is more apt to relax perfectly than one that has been simply dried without salt.

The details of skinning a large mammal should be carefully attended to, as, if neglected, the hair is apt to slip where the salt does not strike the inside of the skin. The lips should be split all around, the nose skinned clear to the tip by splitting the cartilage between the nostrils and opening the nose out flat. The feet should be skinned down to the nails or hoofs, and the ears turned inside out, as shown in Plate XIII, Fig. 1. If this latter detail be neglected, the hair is apt to slip when the ears are afterwards soaked up.

The skin should be examined for blood spots on the hair. These should be sponged with water and combed with a steel comb, the combing breaking up the blood clots. If the skin be very bloody and plenty of water is convenient, the whole skin may be placed into a pool or tub of water and well washed. This is particularly true of mountain sheep or prong-horn antelope. The hair of these animals is tubular and sucks in the blood, and if the blood be allowed to dry on, it will leave a permanent stain and disfigure the specimen. Blood that has dried on the hair while warm

that around bullet holes, will require more washing and combing than cold blood that has soiled the hair during the skinning operations.

When all the blood is out of the hair, hang up the skin by the nose, and by using both hands as a squeezer, beginning at the head, work on down to the tail, thus running the water out of the hair. Two or three manipulations are sufficient, then shake out the skin and allow it to hang a few minutes, when it is ready for dry-salting. Always turn the inverted ears upside down and drain out the water, or the ears may macerate and lose the hair. Should the skin be fat, such as that of a seal or sea lion ordinarily is, the fat should be removed before washing and salting. In skinning a fat animal it is much easier to "beam," or shave off with the curriers' knife as described later, if much fat be left on the skin, rather than skin too closely in spots. When skinned closely, especially in warm weather, a dry glazed surface will form on the inside of these places, and these require much more time and careful manipulation to remove, without cutting the skin, than if a good thickness of fat be left on. It will not strike through a mass of fat and blubber quickly enough to bind down the epidermis before maceration takes place and there is a consequent loss of hair, or "slipping" as it is called. Owing to the impenetrable nature of the epidermis, neither salt nor any other preservative can be made to strike through and bind it down and set the hair, by applying the preservative to the hair side of a skin. It must be absorbed by the inside skin tissue.

After beaming, the skin should be well washed in water containing a little soda or soap, and, after draining a while, the skin should be immersed in gasoline or distillate for a few hours to remove the grease and oil. Carbon tetrachloride is good, but is much more expensive. Greasy white-haired skins, such as harbor seals, polar bears, etc., should always be soaked in gasoline before salting. This is particularly true of white or light colored seals, for if the grease be left in the skin, the hairs suck it up and become clogged with oil. This gradually oxidizes and turns brown, and a permanent dirty yellow stain results. After the gasoline has evaporated, the skin is ready for salting. If it be possible to avoid it, do not salt the skin before the gasoline bath, as salt or brine sets the grease and gasoline will not then dissolve it so readily.

To salt a skin lay it upon the ground or floor, and spread dry

salt evenly over every part of the flesh side, fold the skin together, flesh to flesh, and roll it up. Too much salt will not harm the skin, as it will only take up a certain amount and the balance remains undissolved.

After the skin has been in salt overnight, it is in fine shape for final beaming, and all fat skins should again be beamed as soon as possible in order to get out every bit of grease and oil in the second beaming. A second degreasing with gasoline will make certain that the grease is out. If the grease be left in—and this is especially true of bear hides—the skin is bound to “grease burn” in a year or less, and be utterly worthless. Nothing can be done with a grease-burned skin. The grease rots the skin fibers and the skin disintegrates and falls to pieces. If bear hides are to be mounted, the quicker they are mounted the better; otherwise the next best thing is to “fur-dress,” or tan, the skin as later described.

Sometimes in warm climates, it is next to impossible to save the skin of a large, fat animal. Mr. Leslie Simson informs me that the hot midday sun in equatorial Africa, shining for an hour or so on the freshly killed carcass of a lion, is sufficient to ruin the skin, particularly the tail, which is invariably fat. For some reason, hot sun shining on the carcass of a fat animal, decomposes it much more rapidly than it does a lean one, but of course the latter will suffer also. It is always best to be careful not to allow the sun to shine any longer than necessary upon any part of a fresh skin that is being skinned or transported.

I remember on one occasion, while collecting material for a group of summer deer in Mendocino County, California, having killed and skinned a doe, I rolled the skin up and placed it in a knapsack carried on my back. I started for camp several miles distant where I planned to complete the details of skinning the head and feet. Through carelessness, one of the unskinned ears stuck out from the canvas bag and was fully exposed to the hot midday sun for a few hours. Upon arrival at camp, the sun had so blistered and decomposed the ear that it was entirely ruined.

Skins which may not be fat but which are too thick for the salt to strike through in time to set the epidermis, need to be beamed down soon after salting so as to reduce the thickness of the skin sufficiently to permit the second dose of salt to penetrate. While the skin of an elephant or a rhinoceros might not be fat, the skin

thick in places, and unless thinned down during the salting and drying process, the epidermis in many places is certain to peel off and ruin the specimen for museum purposes. To save the skin of a large elephant in a tropical jungle is a herculean task and takes the constant work of a number of men for several days, cutting down and resalting the skin, before it is safe to allow it to dry for transportation to the coast. In dry-salting a skin, rubbing in the salt, as is generally recommended, is no better than sprinkling or reading the salt on the wet, inner surface. If the skin be fresh and wet, as it should be for salting, the moisture dissolves the salt, which immediately strikes into the skin and drives out the moisture, forming a pickle with the watery fluids of the skin, which runs or rains off while the salt is acting upon the folded or rolled skin. The notion that if plenty of salt be used, it will strike into a fat and thick skin and save the hair, is an illusion; as is the notion that a heavy fat skin may be thrown into salt and alum pickle, or any other pickle, and left there for a month or a year and be of any earthly use for a museum specimen when it is taken out.

The salt must strike through from the flesh side and set the hair and epidermis before they slip. If the skin be too fat or too thick, it will not do it.

For commercial purposes, fur houses recommend using no salt, but simply stretching and drying the fresh skins of fur-bearing animals, either by tacking them out or by the use of stretchers or readers. As a result, many of the skins thus collected and sent by professional trappers lose their hair when the dry skins are later soaked up and put on the beam, or shaving machine. Most skins, especially those of fur-bearing animals, come out softer in the tanning or fur-dressing process if they are stretched and dried without the use of salt, alum, or any other preservative. Hence the demand by the fur houses for stretched, dried skins.

In dry climates, if salt is not to be had, skins of large animals, carefully cleaned and stretched, will in most instances come through in good condition. In air drying, see that no folds or wrinkles be allowed to form in the skin. These retard the drying process, and maceration in the folds loosens the hair so it falls out when the skin is relaxed and beamed preparatory to tanning. In air drying, as in salting skins, the nose, lips, ears, feet and tail should always be carefully skinned. If stripped out, tails like those of

foxes, etc., should be opened underneath for a few inches from the tip, and a piece of heavy twine or a few straws inserted in the tail sheath to insure a circulation of air through it. This should be done with all trappers' skins.

Never use alum, alone or in combination with salt, to cure skin that is designed for mounting, unless it be absolutely necessary, either by reason of the humidity of the climate, or to save the fresh skin of a rare animal that is already in an advanced stage of decomposition and upon which the hair and epidermis are slipping. In the latter case, a strong brine, made by dissolving salt and alum in hot water; painted liberally on the flesh side of the skin, will act quickly. Alum plumps and hardens a skin, and makes it very much more difficult to handle, both in beaming and mounting. In ordinary, dry temperate climates, salt alone will do the work. In hot, humid, tropical climates, dry salt is sometimes useless. The skin mildews, and by reason of its bad property of deliquescing, or drawing moisture from the air, the salt keeps the skin in a moist state all the time until gradually dissolved out again. In such cases, there are two ways of collecting skins and getting them out of the country and into a place where the climatic conditions are more suited to their preservation. Both ways are bad. One method is to use alum alone, and the other is to make up the pickle of Formula 1, and immerse the skins for a week or two, or possibly longer, until they can be gotten out of the country altogether. Collecting skins under these conditions is hard, unsatisfactory work, and it is needless to say that such specimens when finally mounted do not always accurately represent the best workmanship of the preparator.

The salt and sulphuric acid pickle, while being better than dry salt and alum as a preservative because it leaves the skin in a more pliable condition for mounting, also has its great disadvantages. In a general way, it might be said that haired skins, immersed in salt brine, or brine in combination with other materials, deteriorate from the moment they are wet with the pickle. The longer they remain in the brine, the more useless they become. At the same time, injurious as any form of pickle may be, the salt and sulfuric acid pickle has its uses. For large skins, which must be shipped at once without drying out, as for example, sea lions or sea elephants, and hairless mammals like hippos and rhinos, a few days' immer-

n in pickle after degreasing, salting, and beaming, will make certain that the skins will reach their destination in good condition. Pickled skins may safely be shipped in a wet or damp state, and be safe from bugs so long as they remain wet. Skins that have been pickled and dried are also not nearly so apt to be attacked by insects as skins that have been dry-salted and dried, as the pickle leaves all over the hair and skin a fine deposit of salt which acts as repellent against bugs.

One of the worst faults of salt brine, alone or in combination with alum or acid, is that it changes the texture and certain colors of the hair. Bright yellows are transformed to a dingy yellow and dark yellows are changed to purple and brown. For strictly scientific purposes, fur-bearing and certain colored haired skins, should never be wet with salt brine in any form. As an illustration of this fact, I will cite the following: A number of years ago, the late Dr. A. Mearns, U. S. A., while stationed in Arizona, made an extensive collection of the small mammals of that region for the American Museum in New York. In order to save time and work in the field, upon the advice of the late Jenness Richardson, then chief taxidermist of that institution, Dr. Mearns pickled many of the skins in salt and alum pickle (Formula 2) drained off the liquor, and sent the wet skins to the museum, there to be cleaned, dried, and made up into study skins by the department assistants, of which I happened to be one at the time. This program was continued for a long time, until Dr. Mearns, upon a periodical visit to New York, in comparing the pickled specimens with others made by him in the field by the usual dry process, found that, to use his own words, the pickled specimens were "not worth a whoop." The colors and hair texture were so changed that in some instances pickled specimens were hardly recognizable in comparison with the others.

Upon another occasion, the late Dr. J. A. Allen, Curator of Mammals in the American Museum, turned over to the author for mounting for the exhibition collection, a number of dry study skins of small mammals, among them being several chickarees, or red squirrels, from various localities. Some of these were rich in golden bellows. In relaxing in the usual way, by the use of water alone, or wet sawdust or cloths, dry study skins will sometimes slip in a most aggravating way. This happened in so many instances in this particular batch of skins that, in order to try to stop the slipping,

the skins were soaked up in salt brine, by removing the dry filling, packing the interior with pads of cotton saturated with brine, enveloping the entire skin with a brine-soaked cloth, and allowing it to remain overnight to relax. The skins were then scraped, the fur dried with sawdust, and the specimens mounted in the usual way. The salt brine stopped the hair from slipping somewhat.

At that time it was customary to return to Dr. Allen any specimens that were mounted by the Department of Taxidermy, as it was then called, and after he had recatalogued and passed upon them, they were placed in the exhibition collection. Upon this occasion, Dr. Allen asked where this batch of small mammals came from, as he did not recognize them as having been the ones he had selected for mounting. Upon being assured that the specimens were the identical ones he had picked out, a comparison was made with duplicates in the research collection, and as he had truly said, they were not the same. The colors and hair texture had changed. This led to a series of experiments to discover the cause. As a result it was definitely determined that wetting the hair even overnight in salt brine, and then drying it either with corn meal or sawdust, changed certain yellows to purples, and generally darkened the colors of the entire animal, besides killing the gloss, and life or texture of the hair.

Among the animals mounted for the African Hall in the Los Angeles Museum, a group of gerenuk, or Waller's gazelles, was included. The gerenuk is a light yellow on the neck and sides, with a darker mantle on the back. As was done with all the specimens in the African collection, after soaking the dry-salted skins a few hours in water, they were placed in a box of wet sawdust to relax, preparatory to beaming. By carelessness on the part of an assistant, two or three bucketfuls of salt brine were added to the damp sawdust, as the latter had dried out too much to relax the skins properly. A gerenuk skin was placed in the sawdust and covered as usual. Upon removing it a day or two afterwards, it was found that the skin had been so deeply buried in the sawdust that it lay on the bottom of the box and was thoroughly soaked with the brine which naturally settled to the bottom. When the skin was mounted, the yellow colors had so changed as to be distinctly noticeable when compared with the other members of the same mounted group.

All the mammals for this hall were collected in the African

lderness and presented by Mr. Leslie Simson. While collecting, was fortunate in securing as head field preparator, the services N'dolo, an East African native, who had been trained by Akeley, and accompanied and assisted Heller in skinning and preparing for shipment to America, the specimens collected on the Roosevelt African expedition, for the United States National Museum. N'dolo and his chosen assistants gave the greatest attention to the details of skinning, and preparation of the skins in the Simson collection. Every ear was skinned clear to the tip, the lips carefully split and fleshed, and the feet worked out well down to the hoofs or claws. Thick skins, or those requiring it in whole, or in part, such as the neck of a bull kudu or giraffe, were shaved down to the field so as to take no chances with the hair slipping. These skins were all dry-salted, dried in the shade, and folded flat, and in this condition were turned over, together with the accompanying skulls and bones, to Messrs. Newland, Tarlton & Co., Safari outfitters and forwarding agents of Nairobi, British East Africa, for packing and shipment to Los Angeles. Before packing, every skin and bone was dipped, or immersed for a short time in Cooper's dip diluted with water, in order to poison and protect them from the ravages of insects; and as a result, not a live moth or dermestid was found in any skin upon its arrival in the United States, although many of them were several months in transit.

After dipping, any skins that had remained in the solution too long and become too wet, were carefully resalted. All were then hung up and dried thoroughly before packing for final shipment. Some shipments were packed in zinc-lined cases and some were not. I was well dipped so that every part of the skin was touched and thus protected from bugs, unlined wooden packing cases were found all right and the specimens came through in perfect condition. In unlined cases, there is always the element of danger that the case and contents may be soaked with ocean or rain water during the months of transportation by steamer, and the contents ruined. But on the other hand, if skins be packed in air-tight, zinc-lined cases before they are thoroughly dry, the moisture inside will sweat the skins and they will mould and slip, as happened to one shipment of skins from Africa. On the whole, I would much rather take a chance on dipped, dry skins packed in unlined wooden cases, especially in the heat of the tropics.

If dry-salted skins get wet accidentally in transportation, they should be unpacked at once, resalted and again dried out and packed, and no great harm will have been done. I once received some elk hides from Wyoming that taught the shipper a lesson in this respect. He had collected material for a group of elk. The skins had been carefully handled, salted, dried, and packed. In transporting the skins to the railroad a horse, upon which the hides were packed, floundered and fell while crossing a stream, and the hides got wet. The skins were shipped wet, just as they were, by freight. When they arrived the skins were full of maggots and fit only for manufacture into leather. Had these skins been resalted and again dried out, no harm would have resulted from the wetting. Green bones and freshly salted skins should never be packed and shipped in the same box unless separated.

The Cooper's Dip, used in Africa and elsewhere, is an animal dip, used to kill insects on live domestic animals, and is for sale generally all over that country. B. A. Hide Poison,¹ known also as "Veneno," diluted with water according to the directions printed on the label, will answer the same purpose. The active poison used in these preparations is sodium arsenite, which is readily soluble in water. B. A. Hide Poison is used in many parts of the world by hide dealers, and in some of the large warehouses where dry cow and horse hides are kept in great quantities at all times of the year, Veneno only is used to protect them from insects. With these hide dealers, it is dollars and cents, either out or in, if a hide has the epidermis tunneled or furrowed with dermestes, or not. For certain classes of leather in which the "grain," or outside surface, is to remain on the finished product, if the epidermis be ruined by dermestes or other agencies, the skin is useless. Bichloride of mercury, diluted with water and citric acid (Formula 5), will answer as a dip, but is dangerous to handle because of its extremely poisonous qualities. In default of Cooper's Dip or Veneno, white arsenic stirred into water and kept stirred while the skin is being dipped, will answer very well to poison a skin or bones; but sodium arsenite diluted with water is better, as it penetrates the skin and is a more perfect solution. If a skin is already

¹ B. A. Hide Poison (Veneno), in paste, made by the George A. Erkenbrach Company, 115 Maiden Lane, New York City. This poison comes in five-pound sealed metal cans.

infested with bugs, dipping in gasoline will kill them at once. Mounted mammals or heads, if infested with moths or dermestes, should be first sprayed or painted well with gasoline to kill any insect life in the hair. When this has evaporated, a second spraying should be given with dilute Veneno, or corrosive sublimate (Formula 5). When dry, the hair may be combed out and lightly brushed on the surface.

Dry skins of antelope, deer, and other hoofed animals which ordinarily are not greasy, if they are to be kept a long time unmounted, should be kept dry and unbeamed just as they are received until the model or manikin is ready to receive them. Repeated drying and relaxing takes the life out of a skin. If the skin be dry, leave it so until the model is completed; rather than soak up the skin, beam it, and allow it to dry again, and then soak it up perhaps a year or two afterwards for final mounting. The stretch and life is gone, even though the skin be tanned, and considerable difficulty in getting the skin properly to cover and fit the model is generally encountered with skins that have been so treated. Beam the dry skin, relax it, and it is ready to mount. If the fresh, wet, salted skin is received, it should be beamed at once provided it does not require any soaking, as a skin will never again beam so easily as when freshly salted. The ears, nose, lips, and feet should also be beamed and cleaned ready for mounting, and the skin hung up and allowed to dry. When required for mounting, all that is necessary is to relax the skin and it is ready to clothe the manikin.

Keeping Dry Skins.—If a dry skin has been dipped in any of the foregoing solutions, there is seldom any trouble with bugs while the skins are stored and awaiting mounting. Preferably, all dry skins should be kept in large air-tight zinc cans, the top or side lifting off and being furnished with refrigerator clamps to hold it tightly and securely in place when closed. In default of this, large wooden packing cases made of dry seasoned lumber may be used. The whole inside should be lined with builder's or heavy Manila wrapping paper pasted down and the cracks outside also pasted over with paper. It is safer to bisulphide the contents before finally closing the box and to scatter inside, between the skins as they are packed in the can or box, liberal quantities of naphthaline flakes, or "moth balls." These, while not being actually poisonous to insects, act as a repellent and keep them from entering the box.

If kept dry, no harm should come to dry skins which are not greasy while stored in this way. Museum authorities are constantly fighting the four D's. These are Dust, Dampness, Daylight and Dermestes. All four of these disintegrate and play havoc with museum specimens of almost all descriptions, and the more completely any or all of the four are eliminated, the longer the museum life of the specimen.

Relaxing Dry Skins.—Relaxing and beaming a skin and getting it into proper condition to mount, means work and "elbow grease." Generally, the larger the skin, the harder the work. Dry study skins of small mammals are unsatisfactory to mount, and as a rule difficult to relax and get into proper shape for mounting. The ears, lips, and feet are usually not fully skinned when the specimen is made up in the field, and as a result these members are shrunk and as hard and dry as pebbles. If one simply placed the skin in water or kept it wet long enough for these parts to soften, the remainder of the skin would macerate and the hair slip and fall out. Hard, dry spots in a skin must be worked with a scraper or knife from the inside. The moisture then enters and relaxes the fibers of the skin and the latter after a while comes back to the same soft and pliable state it was in when it came off the animal. Moisture must enter from the inside to do quick work. Study skins of most small mammals made in the field, are from trapped animals. Many of these are caught and killed in the trap in the early hours of the evening. The traps are generally not visited and the dead animals taken out until sometime the next morning. As a result, many of the small animals taken in warm climates, such as mice, shrews, etc., are about ready to slip on the belly when they are skinned, and made up. A skin from which the hair is slipping, if allowed to dry, will hold the hair that sticks and dries in, but it also will, in all probability, slip worse when the skin is soaked and relaxed again. This is precisely what happens to many dried study skins when they are soaked up. They appear to be all right, and in good condition, but one never can tell absolutely until a skin is relaxed whether or not it will slip. This statement holds good for all skins—dry or salted, large or small.

To relax the round, or filled study skin of a small mammal, cut the belly stitches with the point of the scissors, spread the sides of the skin apart, and remove the body filling, as with birds' skins.

Stuff the interior with pads of cotton wet with water, wrap pads of wet cotton around the head and each foot and envelop the whole in a damp cloth, or bury it in a box of damp sawdust. The dampening box recommended for relaxing dry bird skins is also good, and the addition of a little lysol stops maceration so the skin may remain in longer with less danger of spoiling. For small skins, overnight in wet cloths, sawdust, or the dampening box is generally a long enough time to soften a skin sufficiently so that the scraping operation may be started. Remove the cotton pads from the inside and, by gentle manipulation, turn the skin inside out.

For mice and shrews, a larger size of the small scraper shown in Plate I, Fig. 2, works very well. Lay the skin flat on the table, and with the rounded end of the scraper, scrape and clean the whole inside of the skin, occasionally wetting it with water applied with a wad of cotton. Wiggle the feet and toes, gently at first until they show signs of bending. Wet them with water and keep working first one foot then the other until they are perfectly relaxed and pliable. If too much strain be put on them before they become pliable, they will snap off. Movement opens the fibers and allows the moisture to enter, and this holds good in relaxing any skins. With the small scraper, pick and work at the lips and nose until they are inverted and soft, and trim around the eyes with small curved scissors. Separate the base of each individual whisker, inside the skin, with the point of the small scraper. For mounting purposes, the whiskers of the large cats, seals, sea lions, etc., should be pulled out. After the specimen is mounted and dry, holes are drilled in their proper places in the lips, and the bases of the whiskers touched with liquid glue and set back into place. If left in the skin they are apt to dry distorted. It is also difficult to properly degrease the skin of the lips unless the whiskers be removed. The ears of small mammals require gentle handling. They are dried and shrunk and, for good work, they must be split from the inside clear to the edges and tip all around, using the flattened wire set in a wooden handle. If the tail has not been opened, and the cotton-covered wire that was put in when the specimen was made up in the field fills the tail so it looks plump and incapable of improvement, allow it to remain in, as this is sometimes difficult to remove. If the tail has been opened and sewed up again, it is generally advisable to cut the stitches and scrape the inside of the

tail in the same way as the body. While scraping the inside of the skin, wet the inner surface from time to time with a wad of cotton wet with water. The scraping and manipulation are continued until the whole skin is pliable and in condition to mount. If the skin shows a disposition to slip during the relaxing process salt brine, or salt and alum pickle may be applied to the flesh side. If this does not stop the hair from slipping, the skin is worthless for mounting purposes. It must, of course, be kept damp by covering it with a damp cloth or putting it in the dampening box, except while the scraping operations are being done. If the fur has become wet or soiled during the scraping and relaxing process, wet a wad of cotton or tow with turpentine, benzine, or coal oil, rub the fur well and partly dry it by rubbing with dry pads, and finish with dry corn meal or sawdust. After dusting the inside with alum and arsenic, or painting the inside with hide poison, the skin is ready to mount.

In scraping skins of thin-skinned animals like rabbits, and mammals larger than mice, if they are too small and delicate to work on the regular tanner's beam, a round beam is constructed of a piece of $\frac{3}{8}$ -inch pipe, covered with rubber hose, and set into a hole bored in the edge of the table, as described in the section on small mammals. Larger beams of this same type may be made of wood or metal covered with rubber tubing or a piece of automobile inner tube. By inserting a piece of $\frac{3}{8}$ -inch pipe, these beams may be made to fit the same hole in the table.

A half of a hack saw blade set and wedged in a slot sawed in the edge of a piece of wood or aluminum, shaped about like an ordinary wooden lath, makes a first-class scraper, and is much better than the old hand scraper recommended in some works on taxidermy. A short shaving blade set in a similar handle and sharpened as usual with the currier's finger steel, with a little practice makes a most perfect tool with which to shave down necks and heavier parts of small skins.

The operator sits in front of the horizontal beam which projects from the table towards him, the skin, inside out, being laid on the beam. With the hack saw blade or the currier's blade, he works over the skin, working the knife or saw either from or towards him and revolving the beam as the occasion requires. The forefinger of the left hand may also be used as a beam in cutting

around the eyes and nose. A pointed shoe knife is also used for this purpose, the edge being kept keen by whetting it on a fine-grained carborundum stone, and then stropping it on a piece of leather tacked flat on a block of wood, oiled and sprinkled with emery or carborundum powder. This gives a fine keen edge.

For larger skins, such as a fox or wildcat, that require scraping and fleshing rather than shaving to reduce the skin thickness, the regular currier's shaving knife handle with a hack saw blade inserted in the place of the shaving blade, does the work quickly and evenly and, on thin skins, lessens the danger of making holes. A hack saw blade may be used on one side of the knife handle and a shaving blade on the other, using the blade for the heavier parts such as the neck and back. Hack saw blades of different sized teeth must be used, as long teeth are apt to cut through thin skins and tear them into ribbons. For fleshing and removing fat from small skins in the field, a light currier's knife handle fitted with a hack saw blade, and used on the upright beam, is worth its weight in gold. Much time could be saved by professional trappers of fur-bearing animals by adopting this useful device, instead of cutting off fat and flesh with an ordinary skinning knife. The danger of making holes in a thin skin like that of an opossum is almost eliminated with the use of a hack saw blade, while to flesh and shave such a skin with a currier's blade, by reason of the long hair, requires much skill and long practice.

Large dry hides should be soaked in water a few hours until they collapse. Borax added to the water hastens relaxation in some cases. They are then drained and buried in wet sawdust and allowed to remain overnight or longer according to the thickness of the skin. The skin is then placed on the beam, and if any wrinkles exist, these should be scraped with a coarse hack saw blade set in the currier's knife handle, breaking up the surface fibers and permitting the moisture to enter. Hard spots should be sponged with warm borax and soap water. Do not try to relax a certain hard wrinkle at once. Work over it, and wet it. Then go at another, and so on until the skin is gradually straightened out. In some instances, on heavy hides, it is necessary to use a keen-edged knife and cut and scoop out inside the thick wrinkles, taking off the impenetrable crust. Do not try to shave a skin with the currier's knife until all wrinkles are out and the skin lies pliable

and even on the beam, otherwise gashes and holes in the skin will be the result.

The shaving beam is made as in Plate XIV, Fig. 1. A base of 2-inch pine, 36 inches long and 12 inches wide, has cross pieces nailed across the bottom at each end to keep the base from warping, projecting 6 inches beyond the sides of the base to steady the beam on the floor. A piece of two-by-six pine is sawed off at the proper angle and screwed fast to the base at an angle of about 45° and supported by an upright brace as shown in the plate. This piece is about 28 inches long and has a $1\frac{3}{16}$ hole bored into the top in the center of the post, to the depth of a wood boring bit. Different width beams are then made, varying from 6 inches down, all being 18 inches long. Each beam has a piece of $\frac{3}{4}$ -inch iron pipe set in the base, the pipe fitting loosely into the hole in the beam-base upright. A wooden screw, taken from a carpenter's wood clamp, is adjusted to screw into the base upright, underneath. By screwing tightly against the pipe, the upper half of the beam is held securely in place. By loosening the screw, the upper beam, with the piece of pipe projecting from its base, lifts off and a beam of another size may be quickly adjusted.

Another method of making a beam with adjustable tops of various sizes is shown in Plate XIV, Fig. 1. In this type, instead of making half-length beams and using pipe dowels, full-length beams of different widths are made, the base of each having a block of wood screwed fast to the upper surface. This block fits into a slot sawed in a cross piece on the base of the beam proper, and when the beam is set into place, this keeps the bottom from shifting. A block of wood is adjusted underneath each beam, as shown in the plate, so that when the screw is tightened, the beam is held securely in position. The principle of both types is the same and they both serve the same purpose.

Different skins and sometimes different parts of the same skin require a different sized beam, and it is better to have one base with interchangeable beams, rather than have a number of entire beams of different sizes. The beams are usually constructed of pine and are rounded off on the top surface. Beams should be covered with sheet rubber. Pieces of discarded inner auto tubes make fine covers, and a two-by-four-inch beam, half-rounded, just slips inside a section of a medium-sized tube snugly without opening

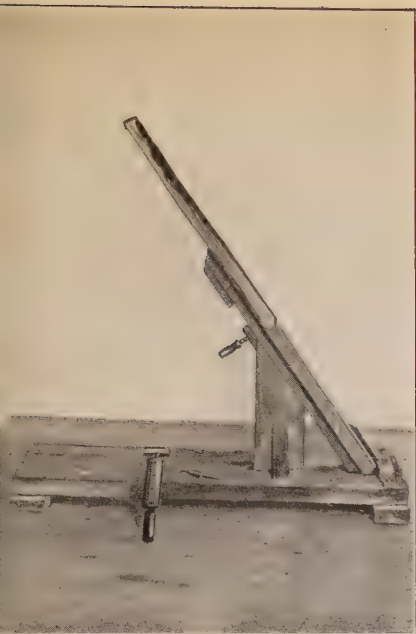


FIG. 1.—Currier's beam with adjustable top. Knife and finger steel below.



FIG. 2.—Beaming or shaving skin with the currier's knife.



FIG. 3.—Crutching a skin.

BEAMING AND SOFTENING SKINS

the tube, and is tacked at the top and the bottom to hold it in place on the beam. The rubber covering keeps the beam from getting nicked and rough from the action of the knife, and a skin on a rubber surface has more life and works easier than upon a hard, unyielding wood surface. When the life is gone from the rubber, it may be replaced with another piece.

For beaming closed legs of deer or other animals, a beam is made of a piece of pipe sawed in two for one half its length and one of these quarters sawed off, leaving a piece of pipe with the end half round for beaming, the other round end entering the beam base as already described. In beaming closed, or "cased," legs, the skin is pulled with flat pliers and turned inside out as far as it will go, first from the foot end, and then from the body end, and the half-round pipe beam slipped in between the doubled skin of the leg and shaved with the currier's knife.

The height of the beam will depend upon the stature of the beamer. The top end of the beam should rest against the pit of the stomach, and not so high up as to interfere with a good, long stroke down the beam. A light rubber or waterproof apron is worn, and the beamer throws his weight against the skin which is thrown over the beam, and thus holds it in position for the knife strokes. Through constant use, holes will wear in aprons at the point of contact with the beam. To avoid this, a piece of inner automobile tube, slit up and opened, is sewed fast across the front of the apron. This may be renewed from time to time as it becomes necessary. By using the rubber, any light apron may be used. Entire rubber aprons, besides being very heavy and a drag on the shoulders, soon wear out in front.

Some beamsters make their knife strokes to the right and down, and others to the left. Some can shave either way. Personally, shaving to the right always came the more natural to me and I am always surer of a right-hand stroke in beaming than a left.

It seems strange that no successful machine for shaving all kinds of large hides has ever been invented and put into general use in tanneries and fur-dressing establishments. Machines are in use that "cut down" large short-haired skins, like horse hides, but even these are none too successful. In fur shops the shaving wheel—a circular steel disc with a turned edge driven with power and revolving at about twenty-five hundred revolutions per minute

—does fast and smooth work on all kinds of skins up to the size of a coyote. But beyond this size, this shaving machine is of little use, as the skin is too bulky to handle and gets in the way of the operation of drawing the inside of the skin back and forth across the turned edge of the revolving disc blade. In tanneries and fur shops all over the civilized world the upright shaving beam and currier's and "skiver's" knives are still used. It would be difficult for the mammal taxidermist to get along without them.

The currier's shaving knife has been in use in tanneries for many years. The knife that is regularly made and sold by dealers in tannery supplies is made of malleable iron and is four times as heavy as is necessary to do most of the work required by any taxidermist. A light, serviceable knife is made by taking the standard shaving knife as a pattern but reducing the width over all to $1\frac{1}{2}$ inches, allowing for a blade 11 inches long. The pattern is laid on a sheet of quarter-inch aluminum, marked with pencil, and cut out with a hack saw. With a wood rasp, the aluminum edges are beveled and the knife finished with a flat file and sandpaper. In the manufactured knife the upper half is joined to the lower at the ends. It is therefore sometimes difficult to open the slot to remove or insert blades. There is no reason for having the upper half joined to the lower. The upper half is simply to clamp and hold the blade in place and does so just as effectually with the top piece loose at the ends. Holes are bored through the two halves and the lower one is tapped out to receive $\frac{5}{16}$ brass, flat-topped machine screws. The heads are countersunk in the upper or loose half through which they run free without threads. Wooden handles are fitted as the beamer desires. This knife is light and does faster and better work than the heavy iron knife and does not rust. The standard lightweight currier's knife weighs about four pounds. The homemade aluminum knife weighs less than one pound. For fine shaving on small skins a smaller and shorter aluminum knife of the same general pattern or type is useful, one taking an $8\frac{1}{2}$ inch blade being very convenient.

Standard blades for currier's knives may be purchased of dealers in tanners' supplies, the Swedish blades being superior to the American. Discarded graphophone, or talking machine springs, cut into proper lengths with tinner's shears, make the best shaving blades for use with the currier's knife. They are evenly tempered and so

thin that they grind down and take a keen edge very quickly. They are of just the proper temper to turn nicely and hold their edge. Hack saw blades heated, and cooled gradually and plunged into water when partly cooled, so as to take out some of the temper, make fairly good shaving blades, but are not to be compared with talking-machine spring blades for all-around work.

To sharpen the blades, a fine-grained power emery wheel with very slow revolution so no sparks will fly, is best. If this is not at hand a water grindstone will answer. Grind a little on one side, then grind a medium bevel on the other, producing a fine, keen, chisel-edge. Steel this with machine oil and the finger steel which is sold for steeling currier's knives. If the finger steel cannot be procured, make one as follows: select a six-inch rat-tail file, and grind off the grooved surface all around on a fine power emery wheel until the file grooves from the center to the tip are entirely lost. Smooth with emery paper. Point the tip like a sharp lead pencil and set the file in a small wooden handle. This makes a first class steel.

To turn the edge of the ground shaving blade, with the sharpened blade in position in the handle in which it was ground, clamp the handle tightly in the vise, and with the turning steel roll over the edge by running the steel along the blade edge and rolling it over at the same time. Begin by holding the turning steel low down and running along and pressing hard at the same time. Next time, hold the steel a little higher or flatter, and press along the edge. Continue this process until the steel goes flat across the edge, the latter having been rolled or turned over like the edge of a carpenter's wood scraper. The turning steel is three-cornered, like a large file, but perfectly smooth. It is a very easy matter to make one by grinding away the grooves on a large three-cornered file, setting it in a wooden handle, and polishing it down smooth. Some beamers use a round turning steel, but the three-cornered one is better.

To sharpen the edge of the turned blade, rest the right or straight handle of the knife on the table, holding the cross-handle with the left hand and keeping the knife elevated at an angle of about 45° . With the finger steel held between the fingers of the right hand, insert the point in the groove at the upper end and run it quickly and smoothly along in the groove until it runs

out at the other end. Repeat this process several times, then lay the flat side of the steel on the top or flat surface of the edge and run it along, back and forth several times, using a discarded broad-based ink bottle a quarter filled with machine oil to drop the steel in when not in use. This keeps it from rusting. During the operation of shaving a skin, from time to time, whenever the blade does not take hold and cut properly, the finger steel is used to whet the edge.

The secret of success in shaving is to be able to keep the edge of the knife sharp with the steel. A dull blade is dangerous to handle, as one never knows just how much pressure to use to make it take hold, and when it does cut, nine times out of ten, it will cut all the way through and make a gash. The edge of a blade will last much longer on fresh, unsalted skins than on salted ones. The salt crystals wear away the edge. For the same reason sand and grit should be kept off the flesh side of skins that are to be beamed. The harder and drier the skin the more quickly the edge is lost. I once beamed down nineteen fresh unsalted California sea lion skins—bulls, cows, and pups—with one pair of blades; and these when I finished were almost as keen as when I began. It is difficult to get blades of just the right temper. The best way is to keep all good blades and discard those that do not hold up after repeated trials. A keen edge—one that cuts at every stroke—is required, and after this is worn off so that steeling does not restore it, the edge will require regrinding and turning. Blades may be ground and turned and a stock of keen-edged blades kept on hand. Then in “cutting down” a skin, when a blade has lost its edge, substitute a sharp one for it.

Practice is all that is necessary and anybody with the ability to handle edged tools will soon get the knack of shaving skins. Practice will also enable you to tell when a skin is in just the proper condition to shave. If a skin is too dry it will require to be wet with water, or warm borax and soapy water. If a skin be too soft and pliable so it stretches out too much under the pressure of the knife, paint the skin with salt brine on the flesh side to harden it. If this does not answer allow the skin to dry out a little. In shaving, be careful of wrinkles in the skin or lumps of any kind, such as knotted hair or cockle-burs, between the skin and the beam. The knife follows the beam and cuts down everything

to one level or plane. If a wrinkle exists, off comes the top of it and a nice hole results. It is a good plan, in shaving, to tilt the knife first backwards or toward you so the edge fails to cut, and run the knife down firmly on the skin all over the cutting area of the beam, thus stretching it out and making certain that it is all clear for the knife strokes. Professional beamers always do this to avoid cutting holes in a skin.

Some skins "cut down" much more easily than others. Zebras, horses, oryx, and some other large hides have a tough cartilaginous lining to the skin. This is very difficult to shave off and must be removed with short knife strokes. Others again, like rhinoceros, seals, bears, and deer, having an open or porous grained skin, shave very easily; and an expert shaver can use a wide, flat beam on such skins, and make long wide shavings, thus producing an evenly shaved and surfaced skin. The thinner a skin is shaved, the better it is for mounting. The skin will stretch, and "take up," or crowd together better on the manikin and will retain its place better when dry. In drying, all skins shrink and pull more or less and the thicker the skin the more the pull, and as a consequence the more difficult it is to keep it from bridging or drumheading across depressions in the model.

Large skins that are too heavy and bulky to be handled on the ordinary upright beam are cut down on a long horizontal beam. This is made longer than the total length of the skin to be shaved, and constructed of a piece of two-by-eight plank, rounded on the upper surface and having sawhorse legs at either end, these being sawed off so as to bring the beam at a convenient height for shaving. For skins with closed necks, one end of the beam is sawed in two and fastened together with bolts, so the beam can be slipped through the neck and the bolts slipped back into place, the skin then lying flesh side up stretched out to its full length on the top of the wide beam. A string is passed through the nostril and looped over a nail driven in the end of the beam, to keep the skin from slipping back during the shaving operation. The shaver stands alongside the skin, beginning at the head and using the currier's knife the same as on the upright beam, and working back toward the tail, shaving the full width of the beam. The skin is turned on the beam with a sharp hay hook,

used on the flesh side only, and prepared for another swath down the center the full length of the skin.

If the operator be unskilled in the use of the currier's knife, carpenter's drawknives, or even long butcher knives may be used with this beam. The large knife used for fleshing cow hides in tanneries and called the "skiving" knife, can also be used. Skins of elephants, rhinoceroses, sea lion bulls, etc., may be cut down to great advantage on the horizontal beam. The trouble with the upright beam on large skins is that the beam cutting area is so small that much time and hard labor are required continually to shift the heavy skin on the beam, more time being lost in shifting the skin than is required to do the actual shaving. With a very large heavy skin, the upright beam is therefore nearly useless, at least until the skin has been cut down on the horizontal beam and reduced in weight and thickness, when it may be finished on the upright beam.

After a skin has been shaved as thinly and evenly as possible, the ear cartilages removed, and the nose and feet carefully shaved and trimmed with a pointed shoe knife, the skin is soaked for half an hour, until it is thoroughly relaxed, in warm water containing a little borax and soap. The skin is then hung up, drained thoroughly, and rolled up hair side out and covered with a wet sack and left so until next morning. If the skin be a haired skin, like a deer or a short-haired African antelope, it is then painted all over the flesh side with B. A. hide poison, followed by a liberal painting with hot carpenter's glue and glycerine, half and half, the mixture not being so rich in glue that it will become rubbery and roll off. It should be painted on quite warm, so it strikes into the skin a little. The skin is then ready to put on the manikin.

Haired skins, such as deer and elk, should never be drummed for mounting, as the drumming process produces permanent whorls or "cowlicks" in the hair, and these are always unsightly in the finished specimen. If the skin is a furred one, like a coyote, the fur should be cleaned out before the skin is placed on the model or manikin. After relaxing and coming out of the warm water and draining, as with a hair skin, the wet hair should be well rubbed with handfuls of tow or burlap until most of the water is absorbed. The fur is then thoroughly wet with turpentine, or coal oil and benzine, mixed, by dipping or otherwise, and again well

rubbed with bunches of tow or burlap, and the wet skin placed in a box of fine dry hardwood sawdust. Oak or redwood sawdust will not answer, as they stain white hair. Fine cedar or mahogany make the best sawdust for cleaning fur. Fine sand mixed with sawdust helps the latter through the hair and thus keeps it from "balling" or clogging. Fine white pine mill dust, from the sandpapering machine of the lumber mill, is very good, particularly on hair that is half or nearly dry. Dry corn meal, either white or yellow, is always good, either for feathers or fur, the grit helping to scour and cleanse at the same time it absorbs moisture. Coarse plaster is good for white feathers or fur, but it is difficult to remove the last traces after the skin is dry. I have known mounted birds or mammals, that had been cleaned with plaster, to sift plaster on the pedestal beneath, years after the specimen had been mounted.

Roll the skin over and over in the box of sawdust, shaking the skin from time to time so the damp sawdust will be replaced with dry, at the roots of the hair. Remove the skin and run a string through the nose of the skin and loop it over a nail driven into a post. With a rattan, or flexible flat stick like a lath, take hold of the rear end of the skin, tighten it a little, and beat the skin on both sides, driving out the sawdust. The sawdusting and beating are better done outside in a current of air if possible, as the fine particles of sawdust float in the air and settle on everything around, besides filling the mouth and nose. Put the skin back in the sawdust again and continue the operation until the fur is plump and fluffy. Sometimes it is necessary to use the steel comb in places before or after the sawdusting process to remove kinks and knots in the hair. The skin is now ready for poisoning and mounting.

In fur-dressing establishments, the sawdust box is replaced by a revolving sheet-iron "drum," and the beating process done with what is known as the "cage," a revolving open wire-mesh drum. The tanner's drum is simply a large sheet-iron cylinder, several feet high, revolving by motor power on an axle, and geared down so that a drum having a diameter of four and a half feet makes about twenty-four revolutions per minute. In revolving, the skins and sawdust drop continually and are not carried over and revolved. The movement of dropping, twisting, and turning works the sawdust into the skin and fur, and this absorbs the moisture.

Ordinarily, to facilitate drying and softening the skin, gas Bunsen burners or open charcoal stoves are arranged below the drum so as to heat the contents. In fur-dressing, skins are seldom put into the drum wet. They are generally hung up and the hair nearly dried out before drumming, as this saves power, and the sawdust does not need to be changed so often. After drumming, skins are put into the cage, which works on the same principle as the drum, but is made of open wire mesh. The skins are revolved as long as necessary to shake out most of the sawdust, when a rattan beating gives the final finish to the fur. On a small scale, a hand-power drum may be easily made by sawing out two wooden circles of one-inch boards about like barrel heads, nailing cleats across them, for the ends, and using a piece of sheet iron tacked around them for the sides. An axle is screwed fast to each end on the outside, so as to leave the inside of the drum free and clear, the axles working in two uprights nailed fast to a wooden base. A door is cut in one end and arranged with hinges and a button to close tightly. A hand crank is fastened to one end, and the cylindrical drum turned like a hand-power grindstone. This is much better than a sawdust box, and does the work quicker and without the sawdust flying all over the room.

Tanning and Fur-Dressing.—The word “tanning” is generally applied to the preparation of hides from which the hair has been removed and the hide manufactured into leather. “Fur-dressing,” or “fur-tanning” is used to indicate the process of preparing skins with the hair or fur left on, the skins being used for rugs, robes, or wearing apparel. Ever since history began, man has tanned and fur-dressed hides and skins for clothing and other purposes. With some uncivilized races, like the Eskimo for example, a knowledge of skin preparation is vital to their existence; and in the civilized world to-day, it would be difficult for man (and woman) to get along without leather and furs. There is hardly a city of any great size in the United States that has not a tannery or fur shop, either large or small. In view of these facts it seems strange that the technique of the leather and fur-dressing industry has not become more generally known and the methods reduced to a more exact science, as has, for instance, the welding and casting of iron and other metals. Many large leather tanneries to-day employ their expert chemists on regular salary to try to

perfect and improve their formulae and processes of making leather. Most tannery proprietors are intensely jealous of improvements in their methods and machinery; and this jealousy and secretiveness is even more general in fur-dressing establishments, so that it is only the favored few who ever see the inside workings of a fur-dressing plant. Hardly any two fur-dressers use exactly the same formulae and methods; and, what is still worse, one could not be prevailed upon to inform the other as to any vital improvement that he has invented. This secretiveness has had much to do with halting the advancement of tanning and fur-dressing; and if the practical workers in these fields had at heart the real advancement of the trade, as in the manufacture of silks and textiles, to-day anybody who wished to know, could readily find out how to make any known grade of leather. Of late years a few books on the subject of leather tanning have appeared, but these are far from being practical treatises, and contain almost nothing about fur-dressing.²

I know a firm in San Francisco which turns out the finest grade of buckskin that I have ever seen. This product is almost like a piece of cheese cloth, so far as pliability and stretch are concerned. It is more like a piece of cloth of some kind than skin. If this firm would publish in a trade journal the exact method employed in making this buckskin, how much it would mean to buckskin makers—and there are many all over the world. But this producer keeps his formulae and methods strictly within the four walls of his tannery. Consequently the rancher or cowboy—here or in Australia or Africa—who wants to make a buckskin shirt must almost sweat blood to dehair and soften a buck or calf skin sufficiently so that it may be utilized as a garment, using little known and impractical methods and formulae that he has dug out of some ancient *Dictionary of Every Day Wants* or *Farm Journal*. Had each and every improvement in leather-making been published as it should have been, and the leather and fur-dressing trades put on a broad basis as are some of the other arts and trades, I do not

² *Modern American Tanning*, Vol. II (Jacobsen Publishing Co., 136 West Lake St., Chicago. 1910). This is a compilation from contributions of practical workers published in the pages of the weekly journal *Hide and Leather*. *The Chemistry of Leather Manufacture*, by John Arthur Wilson (The Chemical Catalog Co., 19 E. 24th St., New York. 1923). *Practical Tanning*, by Allen Rogers, Ph.D. (Henry Carey Baird & Co., Inc., 2 West 45th St., New York. 1922).

hesitate to say that simple methods of treating skins with the hair or fur on, would be common and universally known, so that anybody who desired to do so could take the fresh skin of a cat or a fox, and with a minimum of labor and cost, bring it out as soft and pliable as a piece of cheese cloth. But unfortunately such is not the case and the "recipes" printed in the backs of almanacs and farm journals are still in use; and skins, fur-dressed to-day by the best professional fur-dressers, are not what the world, at this day of enlightenment, should be producing. The tendency nowadays is to cheapen and shorten the process of making leather and dressed skins, so the manufacturer may get his money quickly and easily. Where formerly a side of sole leather would lie in good oak or hemlock bark tan liquor for six months or more to be thoroughly impregnated and tanned by the addition or substitution of chemicals, leather, to all appearances the same, is now produced in as many days; and the expert chemists must earn their salaries by showing their employers where they can save money by shortening and cheapening the process.

Fur-Dressing.—The following formulae and methods of fur tanning are almost entirely the result of my own experiment. I have never been able to get anything but nearly worthless information from books, nor any assistance and advice from practical or professional fur-tanners. I wish my methods and formulae were fuller and better. But fur-dressing is only one small side line in museum preparation and our life time is too short to devote too many years to one thing alone. A material or solution that could be rubbed or painted on the flesh side of a skin and have that skin dry soft and pliable without further work, would be ideal.

But so far, that magical liquid or material has not yet been discovered and made known. At the present day and by the methods given here, tanning or fur-dressing a skin means work and the expenditure of "elbow grease"; and, generally speaking, the larger the skin the harder the work, especially without the use of the machinery generally used in fur tanneries.

To fur dress a skin, proceed in the following manner: Beam, and relax the skin in the usual way, by soaking it in warm water, borax, and soap, or borax soap chips, for sale at all grocers. Use enough of these to produce a good suds when heated and stirred briskly—about a handful of soap chips to five gallons of water.

It is important that all parts of a skin be thoroughly and carefully beamed and relaxed. Any hard spots in the relaxed skin will come out hard in the finished dressed skin, as the tan liquor will not penetrate and act properly on the fibers. Drain and squeeze the water out of the skin and hang it up by the nose to drain further for fifteen minutes.

Skins if not yellow-haired, or if they be not wanted for scientific purposes, are best immersed in tan liquor (Formula 3) for a few hours or overnight, according to the thickness of the skin. A covered stone crock makes an excellent receptacle for holding the tan liquor, the size of the crock depending upon the size and number of skins that are handled. Stone crocks may be purchased in sizes holding from one to twenty gallons. A red fox, having a thin skin, will be sufficiently impregnated and tanned in a couple of hours. Remove the skin and squeeze out the excess liquor with both hands, beginning at the head of the suspended skin and working down to the tip of the tail. Repeat this operation, fold the skin, flesh to flesh, and roll it up, hair side out. Allow it to remain rolled up for a day or longer according to the thickness of the skin. Without washing it out, hang it over a stretched rope or stick of wood to dry out. A skin will dry more evenly if no folds or wrinkles be allowed to form in it while drying. A couple of laths with stout pins driven through the skin at the wrists and ankles into the ends of the sticks or spreaders, hold the skin flat when suspended by the nose with a string. When the skin is about half dry, lay it flat and paint all over the flesh side with warm fat liquor (Formula 3a). Allow the skin to remain lying flat for an hour or two, so the liquor will not run off, then hang the skin up again and allow it to become bone dry all over. Hanging it in the sun or artificial heat will do no harm. Do not stretch or pull the skin while it is drying. Leave it alone. There is no tanning formula known to the author which will bring a fur-dressed skin out soft and pliable without the subsequent painting with fat liquor or oil to lubricate the skin fibers. Oil of any kind placed on the dry skin leaves the surface greasy, but if painted or swabbed on the wet or damp skin, the oil sinks in and disappears from the surface. Professional fur-dressers ordinarily use a sulfonated oil (fish oil treated with sulphuric acid) in the place of fat liquor. This oil is prepared ready for use.

When perfectly dry, paint or swab the flesh side all over with water. A good swab for painting tan liquor or water on skins may be made by covering a handful of cotton with a piece of cheesecloth or burlap and tying it fast to the end of a stick, trimming off the loose ends with scissors. When wet all over, roll up the skin and allow it to remain so for an hour or two to soften. Examine it for hard spots. If any exist, wet them and again roll the skin up. When the skin is softened sufficiently so it will stretch and pull easily in all directions, it is ready for "breaking up." The skin should be damp, not wet. If too wet, allow it to dry a little. The skin fibers must be broken up by mechanical means, and the more a skin is pulled and stretched while it is drying out after dampening, the softer the finished product. If the skin will stand it, or if any thick spots exist, the skin or heavy parts should be shaved down on the beam all over. While in this condition the skin is ready for "crutching" to stretch it out and break up the fibers so the skin will dry soft. In default of a crutching outfit, the skin may be put on the beam and worked with a hack saw blade and a dull shaving blade. The "crutch" or "moon" knife may be purchased from dealers in tanners' supplies, but a homemade one is just as good. Take an old garden hoe, knock out the handle, and by heating straighten the iron shank so it is in the same plane as the hoe, instead of at a right angle. Hunt up an old spade handle with an iron top, knock out the cross piece of the top and drill a hole through the center of the iron. Insert a long screw through the hole, the screw reaching down into the wooden handle, and the iron top revolving easily. This is to fit under the armpit, and if too close, it may be spread or opened as desired. Saw off the other end of the spade handle to the proper length, bore a hole and drive in the hoe. Drill a small hole through the wood and iron top of the hoe and drive in a nail to hold it securely. The hoe should be sharp. A kitchen meat chopper also makes a first-class crutch knife, when set in a wooden handle the same as the hoe, as shown in Plate XIV, Fig. 3. The upper end of the implement which fits the armpit, may be padded if desired.

A "crutching frame" is built by nailing or screwing a piece of two-by-three smooth pine scantling or joist, 6 or 8 feet long, crosswise between two stationary or movable posts. A second scantling cut to rest upon the first, is hinged at the left end with an

iron door hinge, to allow it to be raised at the other end. A piece of scantling sawed in two and hinged in the middle is made fast to the right-hand upright post, the lower end resting upon the upper cross piece. By throwing up the hinged piece at the right, the upper lever of the frame may be raised up, a skin placed between the two cross pieces, and the hinged piece dropped down and struck with the fist, thus clamping the skin tightly between the two cross pieces, as shown in Plate XIV, Fig. 3. When clamped tightly, the skin is grasped near the lower edge with the left hand, and the crutch knife, operated by the right hand and arm, worked down on the taut skin, the amount of weight that is thrown on being governed by the thickness and strength of the skin. Experience will teach just how much weight a skin will stand without tearing. Crutch the skin all over the flesh side lengthwise, then, by raising the lever and readjusting the skin as often as necessary, crutch the skin sidewise. This stretches out the skin and breaks up the fibers, and as much time as desired may be spent in crutching. In fur-dressing establishments, a machine known as a "kicker" is used to break up the fibers and soften the skin.

When the skin is soft and pliable all over, after crutching and beaming, it is ready for the sawdust and drum. The hair is nearly dry and the drumming finishes the operation of fully drying and fluffing the hair. If a wad of burlap wet with coal oil be rubbed over the hair before drumming, it will gloss and clean the hair nicely in combination with the sawdust. Sometimes this is done after drumming also. A warm drum acts more quickly and does better work than a cold one. After being drummed, and beaten with a rattan or flat stick, the skin is again hung up until dry. It may now be crutched again, or it may be put on the beam and thick spots shaved down with the currier's knife to soften them further.

When it becomes bone dry, which may not happen for several days, the skin is ready for sandpapering. In fur shops this is done on a "sanding wheel." This is a large wooden wheel with a 5-inch surface, slightly rounded, and covered with carborundum paper glued on. Sometimes carborundum powder is glued on. The large sheets of carborundum paper used on sanding machines to smooth hardwood floors is the best, as the paper backing is tough and strong. The sanding wheel is run at slow speed so as not to

"burn" a skin or cut it down too rapidly. If a sanding wheel is not available, skins may be placed on the beam and sandpapered with a block of wood covered with sandpaper. A piece of carborundum paper may be cut, fitted, and clamped in the currier's knife-handle, for use on large skins. The sandpapering gives a nice smooth finish to a dressed skin, besides pulling apart the skin fibers and further softening the skin. When the skin is well sandpapered, dust all over the inside with dry talcum powder applied with a pepper box, and brush or rub it in with the hand. After a good beating with the rattan, the skin should be soft and pliable and remain so indefinitely.

The condition of a skin and the season when it was taken determine the softness and strength of the finished product. A skin taken when the animal was shedding, or between seasons, rarely comes out well in fur-dressing or any other process of tanning. The skin at the moulting season thickens, and many of the hairs go through into the flesh. When the skin is cut down thin, many of these hairs pull out and are lost. They also show badly on the flesh side. Skunks, 'coons, bears, and coyotes are particularly bad in this respect.

When a skin is to be used for scientific purposes, in order that no color changes in the hair be wrought by the action of the salt in the tan liquor, after relaxing, the liquor may be painted or swabbed on the flesh side of the skin, without wetting the hair or fur. This takes more time than soaking in the liquor. Paint the skin with the tanning fluid, fold it together lengthwise, flesh to flesh, and roll it up. Repeat this operation every day for several days. Thin skins require only two paintings. Another method of applying the tan liquor is to mix it with oatmeal or bran into a thin paste and apply it with a small trowel all over the flesh side of the skin to the depth of a quarter of an inch. Allow this to dry. In thick skins it may be scraped off when partially dry, and another coating given. When nearly dry the paste is scraped off, the skin painted or swabbed with water, and the fat liquor applied as usual. The balance of the tanning operation is carried on as already described.

If any holes exist in the finished tanned skin, dampen the area surrounding the holes and sew them up neatly; lay the skin flat on the table and hammer the seam to flatten it. If the skin is to be

mounted, wet the flesh side of a furred skin, or soak the whole hide, if a haired skin, in warm, soapy water until it is well relaxed, then fold and roll it up overnight. It will be found soft and pliable the next morning and in fine shape for mounting. If the head only is to be mounted, as in a rug for the floor, the head alone may be first "soaked up" and mounted. When the mounted head is dry, the balance of the skin is painted on the flesh side with water, rolled up, and left overnight to relax. Skin rugs to lie flat on the floor without wrinkles and also to stretch to their fullest extent, must be relaxed and tacked out. After painting the flesh side of the relaxed skin with arsenic water or dilute B. A. Hide Poison, lay the skin flat on the floor or table, flesh side down, and tack it out with stout pins. Very heavy pins known as "blocking pins" are used by furriers for this purpose, as iron nails are liable to leave rust spots in the hair. To tack out and stretch a skin so that it is evenly balanced and without wrinkles requires considerable skill, and sometimes it is necessary to pull out some or most of the pins in stretching, and begin all over again, to insure a nice, smooth, symmetrical rug. Drive a pin at the back of the head, then pull the skin out in length, and drive a second pin at the base of the tail. Pin out each leg so it balances the opposite one, and then pin out the edges all around, pulling and stretching out all the wrinkles. Put in plenty of pins. Brush out the hair and allow the skin to remain tacked out until perfectly dry. Then draw out the pins, and trim the edges all around with a sharp knife—never use scissors as these cut the overlapping hair. The skin is now ready for the cloth lining, and is simply sewed or stitched fast to whatever lining material is desired.

Leather.—Well-made "buckskin," while having its uses, is, generally speaking, poor material of which to make hunting shirts or other garments. It soaks up water like a sponge and then stretches like a wet dishrag, which it then very much resembles. The only redeeming quality it has is pliability and softness. I have seen buckskin trousers made by professionals that looked fine when dry, but as soon as they became wet, were big enough for two men. Upon drying they hardened until almost too stiff to get into.

The cowboy method of making buckskin is to "grain" the skin, or scrape off the hair and epidermis on a beam, using the back of a drawing knife. The inside of the skin is then rubbed with

the fresh brains of the animal, dissolved in warm water. The skin is rolled up for a week, and then worked over a dull ax, or piece of edged iron, in the vise, until the fibers are broken and the skin comes out soft and pliable. They then smoke the skin with wood smoke, as some North American Indians still do, to further soften the skin. Elbow grease is, however, the main tanning factor throughout, just as are the jaws of the Eskimo in their method of tanning by chewing the skin until the grease is extracted and killed by saliva, and the fibers broken up by the teeth.

In tanneries "dehairing," or "unhairing," is done in a variety of ways. One method is to hang the fresh, unsalted skins in a "sweat room." This is a tight room, kept up to a high temperature with steam. The heat and moisture from the steam "sweat" the skin and loosen the hair and epidermis, or "grain" as it is called. The hair is then pulled either by hand or machine, and sold for various purposes. Sheep skins are usually treated in this way, as it leaves the wool in its natural condition and unimpaired by lime or other chemical dehairing substances, the wool being sometimes more valuable than the skin. The usual method of loosening the hair is by the use of lime and red arsenic. These are made into a thick paste and slaked together by the addition of a very little water. After the slaking, more water is added and it is smeared on the flesh side of the beamed and relaxed skin, which is then folded together and one skin piled on top of the other. In one or more days the hair roots are acted upon by the depilatory chemicals and the hair becomes loose. The skin is then placed on a beam and "scudded" or scraped off with a blunt knife. Another method is to replace the red arsenic (arsenic disulphide) with sodium sulphide. This may be used like the arsenic paste, after first slaking the lime by adding a little water and allowing an hour or so for slaking, on the flesh side, or if the hair be not wanted for any purpose, the skin, after beaming and relaxing, is immersed in a liquid solution for a day or two. This softens the hair roots and the hair may then be easily scraped off on the beam, by using a flat, square-cornered stick. A small quantity of the depilatory solution would be about as follows:

Water (boiling)	1 gallon
Brown soap, shaved	½ cake

Cool and add:

Sodium sulphide	} slaked together .. {	1 heaping tablespoon
Unslaked lime		1 pint, dry

During the late war, red arsenic disappeared from the American market and most skins were dehaired in this country by the use of lime and sodium sulphide, and this is now the most used. It is a good plan to scrape off the bulk of the hair as soon as it is sufficiently loosened to scrape easily, then put the skin back into the solution again, together with a handful of borax. This loosens the remaining fine hairs and cleans the epidermis. After the skin is again gone over on the beam with the back edge of a currier's knife shaving blade, the skin is soaked and washed in water, and scrubbed with a scrubbing brush to clean the epidermis.

The skin is then immersed for a day or two in what is known as a "bate." One of the oldest bates, and one that is in common use to-day for the manufacture of certain kinds of leather, is a solution of chicken or pigeon manure. Dog excrement is also used for certain kinds of glove leather. The clean manure is dissolved in hot water and allowed to remain a day or two. A little bran is sometimes added to start fermentation in the mixture. A quart of chicken manure to a gallon of water is about the proper proportion. The object of "bating" is to kill the lime in the skin. After coming out of the lime the skin is plump and hard. After bating, which may take one or two days, the skin is soft and velvety and after washing in water is ready for tanning. A number of manufactured bates are now on the market, one known as "Oropon" being much used and for sale by dealers in tannery supplies. A solution of boracic or lactic acid is also used as a bate instead of hen manure. Tanneries for many years have been trying to get away from the use of bacterial manure bates, but, as before stated, for certain classes of leather no perfect substitute has yet been found.

For use as garments, and for many other purposes, chrome-tanned leather has for many years taken the place of buckskin and bark-tanned leathers. Its quickness, as compared with bark tannage, is greatly in its favor. There are an endless variety of chrome-tannage processes and formulae, hardly any two tanneries treating their leather output in exactly the same way. It is not within the province of this work to enter into a discussion of the

pros and cons of leather tannage. A simple process of chrome tannage and one that will enable the reader to tan a buck hide so it will be suitable for use as a shirt, is the following.

After dehairing, bating, and washing in water, the skin is squeezed out and immersed for one or two days, according to the thickness of the skin, in

1

Water	1 gallon
Salt	1 pound
Alum	$\frac{1}{2}$ pound
Sulphuric acid	1 fluid ounce

Rinse the skin in water, squeeze it out, and hang it up a few hours, then immerse it one or two days in:

2

Water	1 gallon
Bichromate potash, crystals, dissolved in hot water. .	1 ounce

Some tanners use a little sulphuric acid in number 2, and substitute sodium bichromate for potassium bichromate. The solutions are best kept in covered stone crocks. Bichromate of potash solutions decompose wood, and should always be kept in the dark, as light decomposes them. Rinse and wash well in several changes of cold water to eliminate the bulk of the potash, hang the skin up for several hours, then immerse it for a day in:

3

Water	1 gallon
Hyposulphite soda	1 pound
Borax	$\frac{1}{4}$ pound

Some tanners use a little muriatic acid in number 3.

After a thorough washing, the skin is hung up until perfectly dry. It is then dampened and crutched as with fur-tanning, and is then immersed for a day in warm, fat liquor formula:

4

Water	1 gallon
Laundry soap	$\frac{1}{2}$ cake
Stearic acid	$\frac{1}{2}$ bulk of the soap
Washing soda	1 handful
Neat's-foot oil	$\frac{1}{2}$ pint

Slice and melt the soap and stearin in a little boiling water, then add the full complement of water, then the soda and oil.

Keep the solution warm, not hot, and change the position of the skin often by lifting it out of the solution and sousing it down again, turning the skin over at the same time. This shifting should be done in all the soaking processes in order to allow the chemicals to act evenly on all parts of the skin. In tanneries, they are provided with what is known as the "wet drum." This is a water-tight cylinder into which the liquors and skins are put and slowly revolved, like a sawdust drum, thus insuring an even disposition of the chemicals throughout the skin. The fat liquor drum is kept warm by means of hot steam pipes or Bunsen burners placed underneath.

After a day's immersion in the warm fat liquor, or a lesser time for thin skins, without any washing, the skin is dried and then crutched on the flesh side, as in crutching a fur-tanned skin. To smooth the grain side, a block of hard wood with a slightly rounded, perfectly smooth edge is fitted to the crutching blade by slotting the block with a saw, the block resembling an ax head in shape. The grain, or outside, of the skin is crutched with the block, giving it a fine, hard polished surface. When thoroughly dry the flesh side of the skin is sandpapered as usual.

By this process the result obtained is a plump, soft skin which will not stretch when it gets wet. Bichromate of potash should never be used to tan skins that are to be mounted at any future time. It will fill out and plump by wetting, but will not stretch to any extent. It also dries soft again after being wet with water. Skins tanned by this method dry out a dull gray color, and may be dyed with oil dyes dissolved in benzine. Leather dyes and full directions for their use may be procured from tanners' supply houses. Leather made in this way is far superior to buckskin and much more durable. A very good white leather may be made by dehairing and bating as usual, then treating the skin by the regular fur-tanning process.

To chrome-tan a deer hide for a shirt, the time required to perform the work may be very much shortened by the following process:

Beam and relax the skin as usual. Immerse it in a cold solution of sodium sulphide and pancreatin³ to loosen the hair. This solution may be made strong enough to pulp the hair in fifteen

³ Pancreatin (Fairchild Bros. & Foster, Detroit, Mich.).

minutes if desired, but a weaker solution answers every purpose. When the hair is loosened or pulped, the skin will be found soft and flabby and will not require bating, as is usual when lime is used as a dehairing agent. After cleaning off the hair on the beam, wash the skin thoroughly in cold water and it is ready for tanning, either by the fur-tanning method or the regular full-time chrome process. The latter may be shortened and still produce a good grade of leather, as follows:

Rinse and soak three hours in number 1.

Rinse and soak three hours in number 2.

Wash well in several changes of water until the bulk of the bichromate stain is removed, then soak two hours in number 3, handling and moving the skins about occasionally throughout the entire soaking process. Wash well and hang up to dry. Then dampen and pull, stretch, and crutch. Soak three hours in fat liquor number 4, keeping it warm and moving the skin so the liquor will strike in evenly all over. Hang up and when nearly dry, crutch both sides with the wooden block slipped over the crutching blade. The longer a skin remains in the bichromate bath, the thicker and plumper it usually becomes and the greener the color in the finished skin.

Snake skins may be tanned by treating the skin with the glue and glycerine formula Number 19. If they be tanned in the regular way the scales loosen and fall off. Good results may be obtained by first treating the skin with the warm glue and glycerine, and then following with the regular fur-dressing process. But if snake skins are simply to be preserved as specimens, they are better treated with the glue and glycerine formula, then rinsed in water, scraped on the flesh side as in mounting, and stretched out flat on a sheet of paper and both rolled around a tight cylinder of paper and allowed to remain so for a week. When unrolled the skin will always remain flat. Paint the scales with thin shellac to give greater brilliancy and if kept from the light and dust, much of the color and iridescence will remain in the skin. By painting the flesh side with water dyes just after scraping and rinsing, beautiful transparent effects may be gotten. Snake skins may be simply salted and dried in the field, then relaxed in water and put through the regular glue and glycerine formula, retaining their

scales perfectly if the skin be a new one and not about to be shed by the animal.

The making of sole or shoe leather is a trade by itself and many new and improved methods are being devised every year, the main idea being to tan the raw hides as quickly as possible. Combinations of bark and chrome tannage (or vegetable and mineral as they are commonly called) have been developed; and Quebracho and tan barks from South America and other parts of the world are now largely used to replace the fast-disappearing native oak and hemlock bark. Personally, I have never had any hankering for making bark-tanned shoe leather, and the following description of the methods commonly used was given me by an old experienced tanner—a man who had spent his lifetime as a practical worker in bark tanning, starting in the beamhouse and working his way through.

Oak Bark Tannage.—Relax and beam the skin and unhair with lime and sodium sulphide as already described. Bate with hen dung and wash in water. The skin is now ready for tanning. With the draw knife shave a chunk of tan-oak bark into chips. Place a gallon measure full of chips to five gallons of water on the stove and boil an hour or two to extract the tanning properties. Remove, and allow to cool and stand overnight. Strain, and soak the skin in this tan liquor for a week, handling and turning the skin occasionally. Make up another bark solution, making it stronger by adding half again as much bark to the same amount of water, and strain. Transfer the skin to this solution and allow it to soak another week when it is again transferred to a third solution, made with double the original quantity of bark—two gallons of bark chips to five gallons of water. The skin should soak in this liquor two or three weeks, according to its thickness.

Remove the skin, rinse in water, and scrub both sides with a scrubbing brush. Hang up the skin until half dry, then crutch it on both sides. Lay the damp skin flat on the table and paint or mop both sides with neat's-foot oil. Use a caulking iron, or a tool similar in shape, on the flesh side and by pushing it along on the oiled skin, squeeze out the water to allow the oil to enter. Roll both sides with a roller to compress the fibers. To make thinner, firmer leather, hammer it on the table with a flat wooden mallet, or place it on an anvil and beat it with a hammer. Hang the skin

up to dry. To dye the grain side black, paint it with the following:

Logwood chips	1 handful
Water	1 pint
Carbonate soda	1 tablespoonful

Boil fifteen minutes and paint on the skin, hot. Then paint over this with the following, previously prepared and ready for use:

Vinegar	1 pint
Rusty nails or small scraps of iron.....	1 handful

Put the nails in the vinegar and allow the whole to stand a week or more, shaking the bottle occasionally. This gives the leather a blue-black color. Copper sulphate dissolved in water and painted on over the logwood dye will give a jet black. Bichromate of potash dissolved in boiling water gives a red color. Leather dyes of many colors are now regularly manufactured and used in this country.

A salted and beamed deer or other skin, with the hair on, tanned in this way with oak bark liquor, will not lose the hair in tanning, nor will the liquor discolor it. For rugs, etc., deer and other hides may be nicely and easily tanned by this process. A deer hide taken at the beginning of the "short blue" moult, after tanning may be placed on the beam and the long red hairs pulled out, leaving the soft short blue coat, resembling plush.

Dressed skins for research specimens are kept, like bird skins, in air-tight cans in some museums. These are poisoned in the usual way with carbon bisulphide, as a protection against insect pests. Large fur houses use the cold-storage system for protection. Some institutions have a large air-tight skin room in which the tanned skins are hung up by a string through the nose, and to which the labels are attached. The looped string passes through hooks that slide along on poles or pipes stretched across near the ceiling of the room. For poisoning a room of this size, the ordinary method of bisulphiding will not answer, and a stronger and more volatile poisonous gas is used to reach all parts of the interior. In the Museum of Vertebrate Zoölogy, at the University of California, such a room for the storage of large tanned skins has been installed and cyanide fumigation used satisfactorily since 1909. The method of using this gas is supplied by Dr. J. Grinnell, director of that institution, as follows:

University of California

Museum of Vertebrate Zoölogy

Berkeley, California,
April 4, 1922Mr. John Rowley,
Los Angeles Museum,
Los Angeles, California.

DEAR MR. ROWLEY:

Yes, I have used the cyanide method of fumigation of the big skin rooms ever since 1909. It has worked satisfactorily, as determined by the use of "controls."

The only trouble is the element of danger I have felt in applying this method. I have nearly always done the fumigating myself for fear that some one else would become absent-minded at a critical moment and get an overdose of the stuff! Herewith is a detailed statement of the method I employ.

Very truly yours,
J. GRINNELL.

TO FUMIGATE SKIN ROOMS

(Each room is air-tight, zinc-lined, $11\frac{1}{4} \times 20\frac{1}{4} \times 11\frac{1}{2}$ feet.)

Remove floor-traps to ventilator fan shafts.

Prepare, for each room: a large tub, in which set a stone crock, to be covered loosely the last thing with a board (latter to prevent contents from spattering out); three pounds of concentrated commercial sulphuric acid (H_2SO_4); dilute this one-half, putting the proper amount of water, first, in the stone crock, and then adding the full-strength acid slowly; place two pounds broken-up sodium cyanide ($NaCn$, 129 per cent) in a paper bag; when everything else is ready, drop this into the crock (near the door within the skin-room), put board loosely over the top, and close door quickly, being careful not to inhale any of the fumes; lock skin-room door, turn out lights, and hang on door a large placard reading: Danger; Poison; Keep Out.

Fumigation should be started the last thing as the building is left in the evening. It should continue at least twelve hours, or until the next morning at eight o'clock. Then the first thing is to get the key and open the outside ventilator door, then start ventilator fan, and unlock and slightly open the skin-room doors. Leave the rooms thus airing out for at least two hours. At the end of this time remove the crocks, tubs, etc., handling the residue in the crocks with extreme caution, so as not to inhale emanating gases. Empty crocks into sewer, flushing with lots of water; thoroughly clean crocks before putting them away.

To dry out the air in the skin-rooms, so as to prevent mold, keep in each a crock containing about two pounds of commercial calcium chloride ($CaCl_2$). Replace every year or so as seems needed.

Thorough fumigation should be resorted to at least once a year, oftener if any evidence of living moths or dermestids be noticed.

J. GRINNELL.

Mounting

During the last thirty years, the methods of mounting large mammals have undergone a process of evolution. Formerly large mammal skins, after being pickled in a salt and alum bath, beamed, and washed in soda water, were mounted in about the same general way as small mammals—that is, excelsior was wrapped and bound upon the leg bones to replace the muscles, after iron rods had been adjusted. A center board was then put inside the skin and the leg rods and a fourth rod connecting the head were bolted fast to it. The specimen was then suspended upside down and the skin stuffed and rammed full of straw, excelsior, or tow, according to the size of the animal. When “as full as a tick,” the specimen was set upon its feet and bolted fast to a wooden pedestal. Holes were cut in the skin behind the elbows, and with a long iron “pusher”—a piece of iron rod with the end flattened and the rod set in a wooden handle—the interior stuffing was altered and completed. Hollows in the animal were made by sewing through from side to side with a long needle and twine and tying on the outside of the skin, to hold it in place while drying. But few details of external anatomy were attempted as they were impossible to produce correctly by the methods of the upholsterer. Wrinkles or folds in a skin, as for instance those in a living walrus or rhinoceros, were stretched out flat and became a part of the length and girth of the stuffed specimen; so that a walrus, when completed, had somewhat the appearance of a balloon. My sympathies have always been with the men who up to that time had followed the stuffing of large mammals for a living. They earned their daily bread literally “by the sweat of their brow.”

The late seventies or early eighties saw the dawn of the process of evolution that was to revolutionize the mounting of large mammals. The late Prof. Henry A. Ward established in Rochester, N. Y., an institution known as Ward’s Natural Science Establishment, which furnished museums, schools, and private individuals with mounted specimens, skeletons, and general museum materials. The preparators, or workmen, at first were trained men brought over to this country from Europe by Prof. Ward; and they brought with them the methods that were being practiced in Europe at that time.

But such an institution could not long be in existence without the offer of assistance from ambitious youths from all parts of this country, eager to learn the business and develop their latent talent. One after the other they came—Lucas, Hornaday, Critchley, Akeley, Denslow, Turner, Webster, Wood, Fischer, the Santens brothers, and many others—and after a longer or shorter period of apprenticeship, they left Ward's and entered natural history museums and colleges throughout the country. Ward's was therefore a great training school for the development of museum preparatory work; and the advancement in ideals and technique along these lines is due primarily to Prof. Henry A. Ward, and his corps of apprentices, to whom rightfully belong the credit of having done more for improving the standards of taxidermy and museum preparation, than any other men who ever lived.

Many of the young men who entered Ward's, and apprentices who afterward worked with them in other institutions, had brains and ability. They saw that the methods then in use for mounting large mammals were crude and old fashioned, and capable of vast improvement. They had nobody to give them advice; no books on the subject from which they could glean information. They had to figure out the problem alone.

The first real advance in the process of evolution in the art of mounting large mammals was the use of the "clay-covered manikin" which was developed at Ward's and later described by Hornaday in his book *Taxidermy and Zoölogical Collecting*, Scribner's, 1891. This was a step in the right direction and the excelsior and clay manikin soon entirely superseded the old upholstering method of mounting large specimens. By the new process, the legs and skull were made fast to a center board and the supporting leg-irons bolted through the pedestal. The legs and head were placed in the position the finished animal was to assume, and the body built out by "barreling" with wood. The leg muscles were built out with excelsior wrapped and bound on with strong thread, and the body and general form worked out in the same way. When the model, or "manikin" as it was called, was built out satisfactorily, it was coated all over with soft potters' clay and the wet skin put on and sewed fast.

Aside from the mechanical difficulties of constructing such a model, the great trouble with the clay-covered manikin was that

there was nothing under the skin to hold it down in the hollows. It simply lay on the clay, and when dry, it bridged or drum-headed across all depressions; and by reason of its absorbing qualities, when dry, clay, like plaster, unless water-proofed, sucks and absorbs all the oils and moisture from a skin and this in time bursts or tears out the stitches with which it was sewed. Excelsior, or any other fibrous material wrapped or bound on with thread or cord, is a poor material or medium in which to model or try to reproduce form. If it were good, sculptors and others all over the world would be using it. However bad it may have been, for a number of years the clay-covered manikin process was in general use in all the museums and taxidermists' shops of the world and was a great advancement over the laborious method of upholstering large mammals; and to-day many really well mounted specimens prepared by the excelsior and clay method are to be found in many museum exhibition halls.

In making the World's Fair buildings in Chicago in 1892, "staff construction" was largely used. This is the method of covering a steel or wooden frame with wire netting and plastering over it. This construction suggested the method of mounting large mammals which was developed in the American Museum and later described by the present author in *The Art of Taxidermy* (D. Appleton & Co., 1898). While this method had many things to recommend it and was a distinct advance over the clay-covered manikin because the preparator had greater freedom to model the details of external anatomy, and the hard, dry surface permitted the skin to be glued upon it; still, there are too many mechanical difficulties connected with the construction of a staff manikin, and what is perhaps worse, the weight of the finished specimen is too great, although generally lighter than a specimen of the same size mounted by the clay-covered manikin process.

The staff method was another step in the right direction but was in turn superseded by the casting method that is now in general use in most museum laboratories. This method was developed by Carl E. Akeley, at the Field Museum, Chicago. It consists in modeling a clay figure, making a plaster mould of it, and from this mould reproducing a light, hollow papier-mâché cast, upon which the skin is glued. This general method was used by the author and assistants in mounting the large mammals for the

group exhibition series in the California Academy of Sciences Museum, in San Francisco, completed in 1916. After several years' experience with this method, the author was convinced that it was too roundabout and the expense of constructing the final papier-mâché model was altogether too great, both from the standpoint of time and the use of a heavy mould which was afterwards thrown away and wasted. To obviate this, the method now in use by the author and assistants, is to cover the clay model with burlap spread with soft papier-mâché, and when dry make an opening in the side and remove the clay, leaving the hollow papier-mâché model, which is thus produced directly, instead of by the use of a mould. Since both these methods are now in use, a detailed description of them will be given, with the hope that as time goes on, some other enthusiast will develop and publish improvements that will out-distance and supersede them.

The successful mounting of large mammals requires more skill and mechanical ability than any other branch of taxidermy. In addition to being a thorough mechanic in the use of tools, the mammal preparator should be a finished sculptor and have the ability correctly to model and copy animal forms in clay and other materials. To aid him in his work and act as guides in modeling, he can not have too many animal "death masks," or plaster casts of noses, faces, fore and hind legs, shoulders, etc., in various poses. Photographs from life, if well made, are sometimes as valuable for working out a certain pose as studying the live animal at close range, for the reason that in the photograph the lines are fixed and the modeler simply follows them. In addition to this, whenever possible to do so, it is advisable that the living animal be studied closely while a model is in progress. Making a small "plasteline," or prepared clay, model from the living animal is the best way to become familiar with the form of the subject, and with this as a guide, the life-sized model or manikin may be constructed. One cannot correctly copy a certain object unless one knows the exact form of that object. An experienced sculptor of the human figure would not think of attempting to model a nude without having the living subject before him during the entire process of modeling, even though he had for many years been making models of such subjects.

Mounting Large Mammals by Casting.—By the casting method, provided the skin is not to be fitted to the clay model for a try out while it is in process, the model may be suspended from above instead of from below. By suspending from above, as in Plate XV, Fig. 1, more room and greater freedom for the legs and feet are possible. But this really makes no great difference. A modeling pedestal on castors such as is generally used is just as good and where a number of models are under way at one time, several pedestals may be in use.

The pelvis is nailed and wired fast to a body board of the proper length and the board bolted fast to the supporting or suspending upright, as in Plate XV, Fig. 1. As practically no weight is to come on the feet, for a specimen as large as a wapiti and which was used as an illustration in the present instance, a $\frac{1}{4}$ -inch soft iron rod is tied fast to the soaked and relaxed leg bones. A wooden pedestal is constructed upon which the animal is to stand. The hind legs are first adjusted to the pelvis, the heads of the femurs being held in the sockets of the pelvis by drilling a hole through both and passing a wire through and twisting the ends over the top of the pelvis.

The distance from the head of the femur to the head of the humerus, taken from the field measurements, is then chalked off on the center board and the front legs adjusted temporarily. A piece is sawed out of the base of the skull and a pine block fitted into the cavity in the skull and screwed fast. A hole is bored lengthwise through the block before it is made fast inside the skull, and a $\frac{3}{8}$ -inch soft iron rod run through the hole to support the head on the body board. The distance from the eye to the head of the humerus is then measured off and the skull fastened to the center board as in Fig. 1. To support the skull rigidly, a wire is fastened to the horns in heavy heads and the other end attached above. This keeps it from sagging later when the clay is put on.

The general outline of the body is then constructed by drilling a hole into the back of the skull block, inserting the end of a long piece of heavy wire and bending it to the outline of the neck and back, the other end being fastened to the pelvis. A second wire runs from the throat along the under side of the neck and body. To hold these wires rigid, light wooden sticks to act as spreaders



FIG. 1.—The framework completed.



FIG. 2.—The framework covered with excelsior.



FIG. 3.—The clay model completed.



FIG. 4.—The clay wall in position.

MOUNTING BY THE CASTING METHOD

are nailed fast to the center board, and staples are driven into the ends over the outlining wires, as shown in the same figure. Excelsior is then bound on with number 25 linen thread, filling out the body roughly to somewhere near the proper proportions, the thread passing around the neck and body in wrapping, as in Fig. 2. Instead of wrapping with excelsior, burlap and newspapers may be used, as described in the following direct modeling process, Plate XVII, Fig 2. When the body is roughly built out so as to save weight and the handling of a great body of solid clay, the front legs, which have been taken off to make room in wrapping, are again adjusted in their proper position and stapled fast to the pedestal, the upper parts being held in position by the clay that is put on later.

Soft earth modeling clay, commonly called potters' clay, is then spread all over the excelsior, and well pushed into the fiber with a trowel. After a batch of modeling clay has been used over and over, and has been kept soaking in a tub for months or longer, it sometimes becomes very foul. When this happens, spread out the clay in the sun and dry it. Then soak it again in a clean tub, adding salt to the water. This stops the fermentation of the vegetable and other matter in the water and the clay remains sweet. More clay is added and the modeling continued until all the details of the external anatomy and general form are brought out as in Fig. 3. If the skull is to remain in the mounted specimen, as was done in the wapiti here shown, the skull is not modeled now, this being done in papier-mâché later on. If the skull is wanted for research or other purposes, it may be modeled out in clay and a cast used in mounting. A cast skull is just as good but, of course, takes extra time to make. When the modeling is completed, smooth the clay by painting it over with water and a soft, wide brush, and rub it with the flat of the hand to smooth and further perfect the modeling.

Clay of the consistency of putty is rolled out on a board into sheets about half an inch thick and these cut into long strips. A median line is traced in the clay with a modeling tool, running from the head to the tail, both above and below, and down the front and back of each leg, and the clay strips modeled and adjusted along the line, thus cutting the model and legs into halves, as shown in Plate XV, Fig. 4. The clay wall is braced and held in place by

cutting out long V-shaped pieces of tin and sticking them into the clay model against the wall on the rear side. The sides to be cast, including the clay walls, are then painted thinly with stearic acid and kerosene, half and half, heated in a water bath.

Casting plaster is then mixed in a bucket and, with a bowl and a flat brush, the plaster is painted and poured on, until the clay is covered all over with a thin coat. The bucket is washed out and a second batch of plaster mixed. Burlap is cut into squares with shears, and these pieces immersed and soaked in the plaster and laid on over the first coat as in Plate XVI, Fig. 1. To stiffen the legs, iron rods or sticks of wood, running lengthwise of the legs, are laid on the outside of the plaster coating and fastened in position with burlap and plaster. The thickness of the mould is determined by its size, the larger the mould the heavier it must be to avoid breakage in removal and handling. For an elk, an even thickness of about an inch is heavy enough. The edges all around are made solid and heavy to withstand wedging when the mould is taken off.

When the plaster is set, the clay wall all around is removed, and the edges of the mould trimmed smooth if they require it. The clay wall is adjusted to the legs on the reverse side of the model, in order to cast them in two sections, the other half of the model and the plaster edge painted with stearine as before, and the side covered with plaster and burlap to the required thickness. The insides of the legs are then covered with plaster.

When all is set, the ridge of plaster along the joints is cut off with a draw-knife and butcher knife, and wooden wedges driven into the seam all around and down the legs. When one side is loose, it is removed as shown in Plate XVI, Fig. 2. The other pieces are then taken off the model. Should the second half show any disposition to stick, as often happens, the clay model may be partially or wholly dug and cut out of it. The inside leg pieces being joined at the top, are sawed through to separate them for convenience in handling. The clay is then taken from the model and put into the tub again for future use, and the frame dismantled.

The moulds are now "pointed up" and all holes filled with fresh plaster. Should the mould be cracked, set the cracked piece in position upon the other half of the mould, and put patches of bur-



FIG. 1.—The plaster on one side.



FIG. 2.—The plaster mould removed from one side.

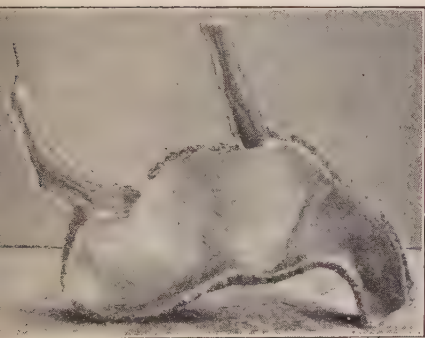


FIG. 3.—One half of the mould filled with papier-mâché and wire cloth.



FIG. 4.—The completed model.

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ap and plaster on the outside to reinforce and hold it in place. Brush out the inside of the moulds with a whisk broom, and they are ready for filling.

There are a number of methods by which this may be done. If paper cast is preferred, the paper process may be used, but is not recommended, as the only good quality it has is lightness when dry. It is far from being accurate owing to the warpage and the twisting in drying. The method invented and used by Akeley in mounting many of the animals in the Field Museum, was generally as follows: The inside of the mould was painted with hot carpenter's glue. Wet cheesecloth was then laid on the wet glue surface with a flat brush until the moulds were lined smoothly and evenly all over. A coat of papier-mâché was then spread evenly over this. Soft wire cloth—about number 24 wire and $\frac{1}{8}$ -inch mesh, galvanized before and not after weaving so as to leave it unsoldered at the joints in galvanizing, like ordinary mosquito netting—was then put into the mould. The edges all around were held down with nails driven through a square of rubber gasket packing into the plaster mould, as shown in Plate XVI, Fig. 3. The netting is flexible and readily takes the general form of the inside of the mould. When in place, soft papier-mâché was forced through the meshes of the netting, filling it and binding it fast to the first layer of composition underneath. This was painted with shellac, and a second layer of mâché, netting, mâché, and shellac given on larger specimens to give strength. All the pieces of the mould were thus filled and set aside to dry. When bone dry, the moulds were immersed in water. The water sucks into the plaster mould, soaks up the glue with which the interior of the mould was painted, and relieves the papier-mâché cast, which lifts out of the mould easily.

The edges of the leg pieces were then trimmed off with curved inner's shears, and threaded rods for the support of the mounted animal placed in position in the lower leg casts, which were put back again into the moulds after trimming. The lower leg casts were then filled level full of soft mâché and tied and clamped together. When partly dry, the inside half-moulds of the legs were lifted off and the legs allowed to dry out as shown in Fig. 3. The two halves of the animal were then lifted out of the moulds and the edges trimmed. Small holes were drilled all along the edges

of both casts, coming opposite each other, and wires passed through and twisted together and tightened, thus holding the two halves together.

The model was then set up on a pedestal, the nuts above and below on the leg rods holding it securely in place. The joints were then filled and modeled over with *mâché*. The skull was adjusted to the hollow neck and modeled fast with *mâché*, and after the nose and head modeling was completed, the manikin was set aside to dry out, as in Plate XVI, Fig. 4. In order to get the skin to go on the model, the horns had been previously taken off by sawing off the bone to which they are attached on top of the skull. Screws driven down through the bone into the block of wood in the skull after the skin is on, hold the horns securely in place.

In order that no seams should show on the legs, at the same time the leg rods were inserted in the casts, tin dowel cases were also put in and filled around solid with soft *mâché*. When dry the legs were sawed off near the body with a hack saw, cutting through the center of the dowel tins. Wooden dowels for the hind legs and flat iron for the front legs were then inserted in the dowel cases of the lower legs and pins driven in to hold the dowels tight and keep them from slipping out. The reason for putting in larger wooden dowels in the hind legs is that the diameter of the upper leg is larger and there is more room for a larger dowel, as in Plate XIX, Fig. 2. When the skin was relaxed and ready to go on the model, which has been shellacked and dried, the legs were slipped into the skin, the latter brought down over the head and the leg dowels painted with soft *mâché* and pushed up into the upper half of the dowel case and a pin put through into a hole previously drilled for its reception. The horns were then screwed on, and the skin adjusted and sewed up along the back of the head and belly.

Another method of filling the mould and the one more generally used, although possibly not so absolutely accurate as that just described, involves less labor and answers just as well. The inside of the moulds are painted all over with stearine and kerosene. Wet cheesecloth is put on with a brush and flour paste, the latter being painted on thinly before and after the cloth is in. Papier-mâché is coated over this with a trowel, and then wet burlap, spread on the table and troweled with *mâché*, made with thick gum arabic instead

f glue, is pressed into the mould in pieces. A coat of a reddish color may be given for a second lining. No wire cloth is used. The inside may be further strengthened by using plaster and burlap squares pasted all over. When dry, this cast will relieve easily from the mould without soaking in water. This does away with the expensive and laborious wire cloth process and answers every purpose. When one considers that all a model has to support is a wet skin, and afterwards a dry one that will almost stand up and support itself, why make a model so very thick and strong? It is wasted energy and material. Strong, reinforced construction is unnecessary. I have successfully mounted animals as large as a full moose and an adult bull Steller's sea lion with burlap and papier-mâché without the use of wire cloth. This material, if waterproofed so it will not relax and collapse after the wet skin is put over it, as so often happens with paper models, is sufficiently strong if well braced and reinforced inside, to hold up an elephant skin. The chief difficulty with the casting method of mounting large mammals lies in the fact that it is too roundabout and involves far too much labor and waste of materials. If a number of individuals were to be mounted on casts from the same mould, as is the case with custom taxidermists in mounting deer heads, the process would be a labor saver. But this is seldom the case in museum work, where one cast is generally made and then the mould is broken up and carted to the dump. Large mammal moulds are heavy and bulky to store and unless there was a reasonable assurance that at some later date another cast would be required, the storage space would ordinarily be worth more than the mould.

In order to shorten and cheapen the process and do away with the casting entirely, the author evolved the following direct modeling method, which cuts down the cost of mounting a large mammal by the casting process over 50 per cent, and gives results that are just as good if not, in some instances, better. Furthermore, there are not so many mechanical difficulties to be overcome in the direct modeling process. It takes an experienced mechanic to construct a clay model, cast it, and make a reinforced papier-mâché replica that is absolutely accurate. I have seen many well-made clay models that were spoiled by assistants in the future processes of casting and reproduction in papier-mâché. One chief fault is that if the lower legs are not handled properly and the mould

edges not accurately adjusted, the lower legs will come out too thick and the skin sometimes will not slip over them. This is rare but I have known it to happen.

Mounting Large Mammals by Direct Modeling.—Soak the dry leg bones in water to relax the joints. Clean off the tendons with a knife. For a small deer or an animal of similar size, cut $\frac{1}{4}$ -inch soft iron rods six inches shorter than the leg. Thread one end of each rod for a distance of $2\frac{1}{2}$ inches and fit two washers and two nuts to each rod, the nuts being adjusted to run freely.

For the hind leg, cut out the top and back side of the calcaneum or heel bone, and a short distance below, so the rod is countersunk flush with the bone. Put the threaded end of the rod in the vise and clamp it tightly just over the thread. Take a piece of pipe about a foot long that fits the rod loosely. Slide the pipe down over the rod and bend it close to the vise. This makes the first bend where the rod enters the hole in the pedestal. Make the next bend about three inches above this and in the opposite direction as in Plate XVII, Fig. 1.

Lay the rod along the back of the hind leg bone with the bottom of the metatarsal joint even with the top bend of the iron. Place the leg rod so the iron lies in the groove which was cut in the calcaneum and bend over the top, allowing the rod to run parallel with the tibia, when this is in the approximate position in which the leg is to be placed. The upper leg bones are not attached to the rod. Holes are drilled through the lower leg bone, wires inserted, and twisted together over the rod to hold it securely to the bone. The front leg bones require no cutting out. Make the bends in the lower ends of the rods exactly as in the hind legs. Drill the lower leg bones at the ankle and just below the knee, pass wires through and twist them over the rod, as in the hind legs. This rod runs straight up and touches the upper bones only on the inside of the elbow. A hole is drilled through the elbow at this point, a piece of cord passed through, and tied around the rod holding it fast at this point. In the old method of allowing the rod in the hind leg to follow up the back of the entire leg bones, the rod was always in the way of the depression between the large tendon (Achilles) and the tibia. This space should always be kept entirely free. In the present method, the rod takes the place of the tendon



FIG. 1.—The framework completed.

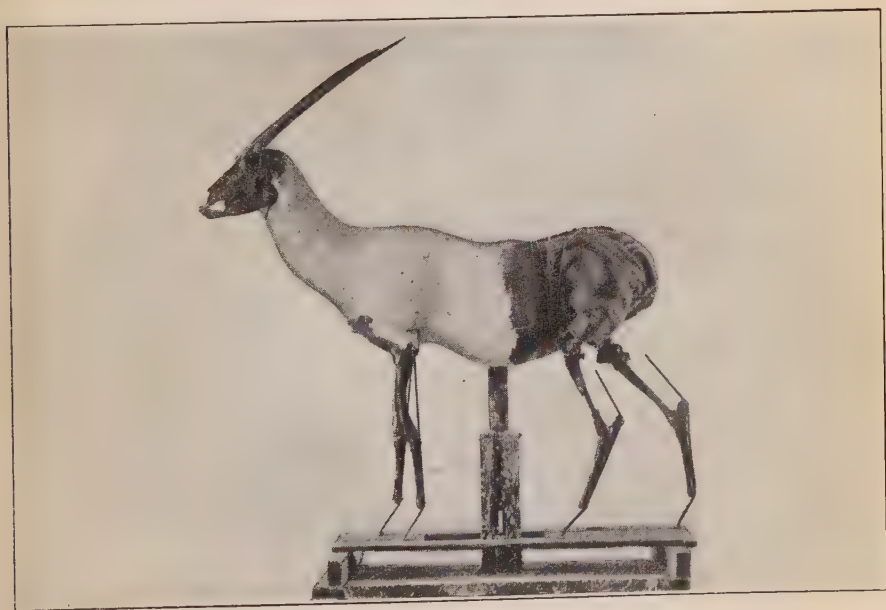


FIG. 2.—The framework with burlap and partly covered with plaster.

MOUNTING BY THE DIRECT MODELING METHOD

as shown in Fig. 1. Afterward a piece of wire is bound fast to the upper ends of this rod and passed through a hole drilled in the rear end of the pelvis, to outline the back of the upper hind leg.

Construct a modeling pedestal of a piece of two-by-twelve-inch pine, with two-by-four cross pieces at each end to which castors are attached. Cut a hole in the center and bolt, screw, and wedge an upright piece of two-by-six pine so it stands upright and perfectly square every way with the base. Saw a slot in this upright for $\frac{3}{8}$ bolts to slide in. Select a piece of strong hard wood, oak for example, one-by-three inches, long enough to reach from the top of the back of the animal to the pedestal. Bore holes through this piece and place two bolts, furnished with washers and nuts, through the holes and through the slot in the pedestal upright, the bolts sliding up and down in the slot with the oak piece. By tightening the nuts, the oak piece is adjusted at any desired height.

A second pedestal of one-by-twelve pine for the animal to stand upon is made by nailing pieces of two-by-four pine scantling across each end. A hole is sawed in the center and this pedestal dropped down over the central supporting post of the modeling pedestal, as shown in Fig. 1.

For a body board, cut a piece of soft pine board $\frac{3}{4}$ x 6 inches, and the length of the body of the animal without the head and neck. Cut out one end of the board, adjust, and fasten on the pelvis by drilling holes through it and nailing it to the center board. Bolt this board securely to the upright in the pedestal, the upright coming generally about the middle of the board as in Fig. 1. Adjust the hind legs to the pelvis by drilling a hole through the head of the femur and straight through the socket of the pelvis, and pass a wire through both femurs and twist the ends together above the pelvis.

Select a good "broad side" photograph of the living animal and use this for pose and form. Pose the hind legs and mark the places on the pedestal where the leg rods touch. Bore holes in the pedestal at these points, and pass the threaded ends of the rods through, with a washer and nut above and the same below and tighten them with a wrench. By raising or lowering the body board by loosening and tightening the bolts in the sliding upright, the legs may be bent at will until the correct angles are made. By pulling on the

rods above, the legs may be perfectly adjusted and the hocks brought together.

So far, no measurements have been necessary, as with the pelvis at the proper angle on the body board and the heads of the femurs in the sockets, this height and width are bound to be correct. In default of measurements, most hoofed animals and many others, may be made to come inside of a square, measuring from the head of the humerus to the rear end of the pelvis the same as from the ground to the top of the shoulders, the head and neck being outside of the square. Most animals are also about the same width across the outsides of the humeri as they are across the outsides of the femurs.

The field measurement from femur to humerus is looked up, and with a yard stick, this distance is marked off on the body board, and the board sawed off to this length. Hold the front legs in position on the pedestal, mark for the holes, and bore and set the front legs in place the same as the hind legs. Adjust the legs and tighten the nuts below, being careful that the bottoms of the bones are the correct distance from the pedestal to allow for the length of the feet. See that the heads of the humeri are the proper distance apart so as to conform to the chest measurement. The fore legs are held rigidly in position on the pedestal by reason of the nuts and washers below and are not attached to the body board above, and may now be accurately adjusted by simply bending them into place, as shown in Fig. 1.

We are now ready for the head. With a hack saw, saw a slot in the under side of the skull, exactly the same as in mounting a deer head, remove the chunk of bone with a chisel and mallet, and insert a block of wood with a hole bored lengthwise through it for a $\frac{3}{8}$ -inch iron rod, and screw the block fast with screws driven into it through the skull. The lower jaw is attached by drilling holes through the angles of the jaw and driving a nail through them into the block. A piece of small wire at the front end of the jaw holds it firmly in place. With the hack saw, cut off the frontal bone, or top of the head, with the horns attached, so they lift off but remain attached to the piece of skull sawed off. Drill holes through the piece of skull and countersink them for wood screws. Set the horns in place on the skull and drive in the screws to reach down into the wooden block and hold the horns

rigidly in place. The object of having the horns detachable is to enable the skull to pass through the closed neck skin when the skin is later placed on the model.

To pose the skull and hold it in position take a $\frac{3}{8}$ -inch iron rod and bend it at a right angle at one end and fasten it to the front end of the body board by drilling holes, passing wires through, and twisting them over the rod. Slip the skull on the rod, measure off the distance called for in the field measurement from eye to humerus, cut the rod to the proper length, bend it sharply at the base of the skull so it will be out of the way in modeling, and pose the head in the desired attitude.

Bore a hole in the back of the wooden block at the base of the skull, fit into the hole one end of a long piece of number 8 wire and bend it from the head to the pelvis so as to draw a wire outline of the back of the neck and upper part of the body. Staple the tail end of the wire fast to the body board and the wire will support itself wherever placed. Do the same thing below, being careful that the wire at the brisket in a standing deer does not hang below the elbow. Staple the lower wire to the side of the pedestal upright and the rear end to the body board under the pelvis. Bend the wires until they represent an outline of the neck and body of the animal, but considerably smaller than the original. To hold them firmly in place, with lath nails, nail flat lathlike pieces of wood across the body board, the ends terminating where they touch the outlining wires. Drill a hole through these sticks or spreaders, and tie them fast to the wires, thus bracing them firmly.

Having worked out the general form of the body with the outlining wires, as in Plate XVII, Fig. 1, leaving the depth behind the shoulder a couple of inches less than the field measurement, the body is barreled out in the following way: Cut a piece of burlap, or sacking, long and wide enough to loosely envelop the neck and body. Cut and fit it and sew it along the under side, sewing it fast to the outlining body wires, top and bottom. Leave the burlap loose all over so that when stuffed it will come somewhere near the proper proportions. When all sewed up, with the humeri outside the burlap, cut a slit along the top of the burlap and stuff the interior with crumpled newspapers, made by unfolding and crumpling a whole newspaper sheet between the hands, and rolling it roughly into a loose ball. Keep the body inside the proper dimen-

sions so as to allow for the clay coating. Should the burlap be too loose at any point, bunch or gather it up, and sew it together with a sack needle and twine. When the stuffed body and neck are completed, sew up the slit along the back and wrap with twine behind the shoulders and in front of the pelvis to produce the natural hollows in the body at these points. Wet the burlap by painting it with water, and then coat it all over with plaster mixed with a little coarse wood pulp. When set, give it a second coating of thick plaster and pulp, leaving it rough on the belly for attachment for the clay, as in Plate XVII, Fig. 2.

Mix potter's clay with water and work it with a spade on a piece of board until it handles easily with a trowel. Clay in proper condition for modeling may be purchased at pottery works. At this stage the photograph of the living animal is of great assistance in working out the form. In long-haired animals, the exterior anatomy must be modeled stronger and bolder than in short-haired ones. Model the neck and body down to the elbows and knees, but not lower than these points, as in Plate XVIII, Fig. 1.

When the modeling is completed, smooth the clay all over with the hand, and give the entire clay body, skull, and leg bones a coat of shellac. When this is dry, cover the whole with wet cheesecloth, painted with warm stearine and kerosene, or lard, applied with a wide flat brush, patching wherever necessary with smaller pieces. After painting over the cheesecloth with stearine to bind it firmly to the clay, rub and smooth it with the hand. In using stearine and coal oil, be careful not to spatter any in the eyes, as it irritates badly. When all covered, the model is ready for its papier-mâché covering.

Select a grade of thin open-mesh burlap and cut it long enough to reach from the head to the tail, and wide enough to reach from the middle of the back and wrap around the median line of the belly. In small animals, the clay model may be enveloped with one piece, but larger models are best covered by using two pieces, first one side then the other. Trim off the selvaged border of the burlap and soak the latter in water for five minutes. Wring it out and spread the burlap flat on the floor or table. With the hand, smear and spread the burlap smoothly and evenly with soft mâché made by using wood pulp, plaster, water, gum arabic, and a little liquid glue to keep it from setting. A little burnt sienna,

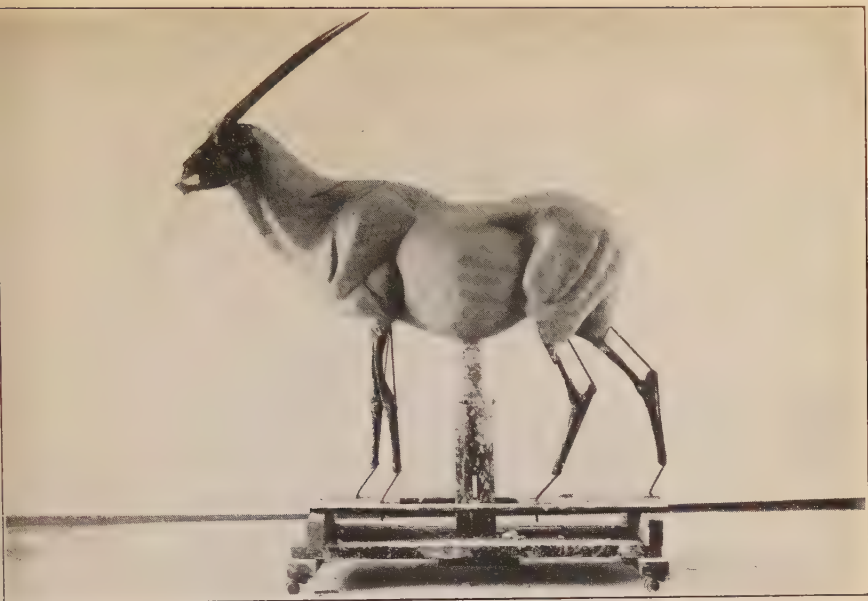


FIG. 1.—The clay model completed.

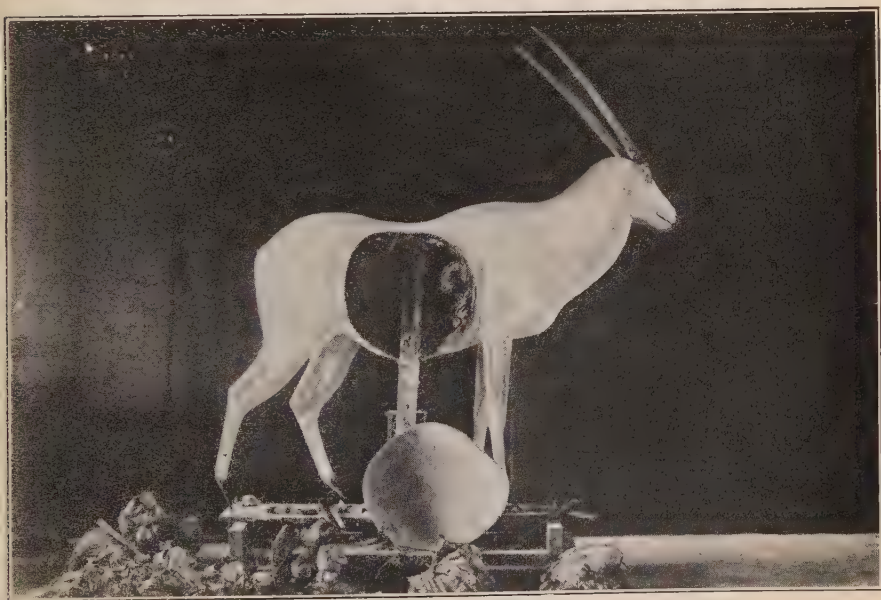


FIG. 2.—Cleaning out the interior.

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dry, is also mixed in to color the first coat when more than one coating of burlap and mâché are put on a model. Put the mâché-coated burlap on the model, mâché side down, and with the hands, smooth and model it carefully into every line and depression, cutting and fitting it with shears. Envelop the entire model, first one side and then the other, the edges overlapping an inch or more along the back and belly, and patching with smaller pieces wherever necessary. With the hands, rub colored mâché all over the burlap after it is in place, grinding it well in so as to fill the meshes of the cloth, and making the burlap fit the model in all depressions. A second coating of burlap spread with clear white mâché is given the entire model, and this outside coat rubbed and smoothed with clear white mâché. For small animals, one coat of burlap and mâché is sufficient, but for a bull moose or bison, three coats are necessary to produce a firm strong model.

The modeling and finishing of the neck and body having been completed, only the head and legs remain to be modeled. This is done with mâché made with water, plaster, tow, gum arabic, and a little glue. Before the legs are modeled, with a hack saw, cut the front leg bones completely through just above the knees, and the hind legs about halfway up the tibia, and allow the bones to remain in position. Drill a hole in the front of the bone of the front legs just above the knee, and insert one end of a piece of number 8 wire, and bend the wire up and into the mâché of the lower shoulder. This should be done before the second coat of burlap is put on the body, and the wire allowed to rest between the two layers, thus insuring a good firm hold and reinforcing the modeling material of the front legs.

Model the upper legs first. Cut and fit a piece of wire netting to fit the depression between the bone and the large tendon on the hind leg and wire it in place. Model the tendons on the lower legs with papier-mâché and cover this while soft with a strip of cheesecloth spread with mâché and laid on mâché side down, the cheesecloth wrapping halfway around the leg, and the edges smoothed out on the sides of the bone. A second piece is thus put on the front side of the bone, and modeled and smoothed with the modeling tool and the fingers. This makes a good firm attachment for the tendons and keeps them from being broken off later in handling.

The modeling of the upper legs may be perfected by carving

with a sharp knife and the modeling finished with clear mâché, or mâché with a little dry cork dust added. The head and nose are modeled with mâché, blood vessels or veinings being represented by mixing tow with mâché and rolling it out on the table to the proper size; or by spreading cheesecloth with mâché and rolling it out on the table with the flat of the hand. When the modeling is completed, the whole is set aside to dry, as in Plate XIX, Fig. 1.

In good drying weather, in about ten days if the mâché is dry and hard, saw out a circular piece of the mâché shell reaching from the back to the belly and from the shoulder to the hind leg, cutting as small a hole as necessary to clean out the interior, as in Plate XVIII, Fig. 2. Dig out the clay and throw it back into the tub. With saw, chisel, long nippers, and a long knife, cut away everything in sight. Saw the center board in two, and remove the paper and burlap. By pulling on the cheesecloth that was placed on the clay model, the clay comes away readily, leaving the clean hollow papier-mâché model, supported by its legs. Lift the model up off the modeling pedestal without removing the animal from the top or permanent pedestal. The upper leg bones, having been sawed through above the knees and hocks, pull out readily from the inside, leaving only the lower leg bones in the model, fast to the supporting leg rods.

Allow the model to dry out a day or two, leaving the hole open to facilitate drying. Paint the interior with shellac and when this is dry, reinforce the whole inside with squares of burlap spread with plaster, gum arabic, and wood pulp. Large models may be cross-braced with wood or steel braces, wire cloth, or any reinforcing materials desired. A hole is drilled through the model and a tail wire fastened from inside.

If the animal be short-haired and the legs not opened in skinning, if it is desired to "lift off" the legs and show no seams in the completed specimen, tin dowel cases are inserted in each leg. These are made as follows: For the front legs, take a piece of flat iron, $\frac{1}{4} \times 1 \times 8$ inches long. Tightly bend a piece of thin sheet tin once around it and wind it with thin wire to keep it tightly closed. Solder the overlapping joint, so that the iron slips in and out of the tin casing easily. For the hind legs, which allow a bigger interior doweling surface, for a deer take a piece of pine wood $1 \times 3 \times 8$ inches long and cover it snugly with tin, and solder



FIG. 1.—The completed model.

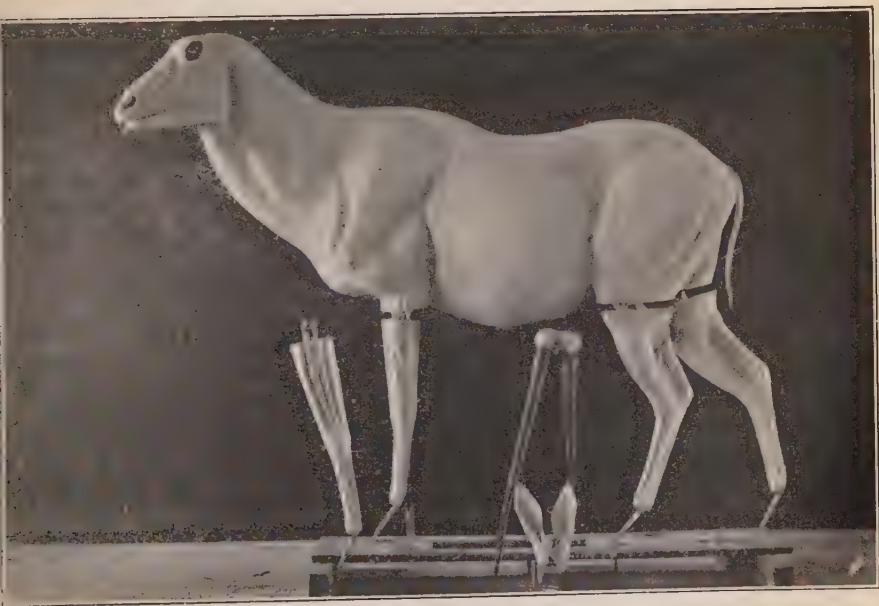


FIG. 2.—The legs, horns, and ears taken off ready for the skin.

MOUNTING BY THE DIRECT MODELING METHOD

the joint as before. Remove the iron and wood dowels, tie them together, number with a pencil, and hang them up. Cover the tin dowel cases with a good coating of mâché and allow this to dry. This keeps them from collapsing. When dry and hard, these are inserted in the inside of each leg, and filled around full of tow and gum arabic mâché. The model is set aside to dry. The shell taken from the side is then set in place, holes drilled through both edges for the reception of wires, the shell removed and lined with burlap and plaster, again adjusted and wired fast by twisting the wires together and snipping off the excess ends. To smooth it, paint the whole model, excepting the lower legs and head, with thin mâché, and cover with wet cheesecloth adjusted and smoothed with a wide flat brush. When dry, paint the whole with hot wax and carbon tetrachloride to waterproof it, and next day paint with shellac.

With a high-backed hack saw, saw the legs off near the body, cutting through the tin dowel cases which were placed inside in such a position that the saw strikes them about midway or nearly so. Coat the lower half of each dowel with glue and plaster, mixed, and drive it firmly into the dowel case of the lower leg, leaving half the dowel projecting for insertion in the upper leg. Put the leg in position on the body and drill a hole through from outside to inside, the drill passing through the wood or iron dowel. Then drive a wire pin through and cut the ends off flush, thus securing the dowel in the lower leg, as shown in Plate XIX, Fig. 2. The pin in the upper leg above the saw cut is left loose and is not finally driven in until the skin is put on later. After the ears are modeled on and the tail wrapped with tow and coated with mâché, the model is ready for the skin as in Plate XIX, Fig. 2.

By the direct modeling method, the same result is attained as in the casting process, in that a hard hollow model is made in both cases, but this is done in about half the time by the direct process.

Treatment of the Ear.—If the fresh ears of large mammals be allowed to dry without separating the rear skin from the inside cartilage and inserting some material to stiffen the ear, this when dry will be shrunken and ill-shaped. I have seen mounted deer heads in which the ears had not been inverted in skinning and a piece of thin brass wire bent along the back edges and sewed fast with thread. When the stitches rotted out, owing to the sulphuric

acid pickle with which the skins had been treated, and the wire came loose later on, the ears crumpled up like a dry leaf.

Much of the character of the head of an animal, like a deer for example, lies in the ear and if this be not treated and posed properly the job is a failure. In mice, rabbits, and animals with thin ears, the ear cartilage is very delicate and the ear should be inverted and the cartilage left in and backed up, or reinforced inside, with soft wax or papier-mâché, injected into the split ear, and squeezed and modeled into shape from the outside. To keep thin cartilages from shrinking and curling, paint the inverted poisoned ear with warm glue and glycerine composition. This keeps the cartilage soft and transparent and the modeling material that is then injected inside dries and holds the ear in proper shape. But in thick ear cartilages, like those of a deer, it is difficult to keep the cartilage from shrinking and warping, and the best way out of the difficulty is to remove the cartilage altogether as shown in Plate XIII, Fig. 2, and replace it with some material that will hold up and stiffen the ear skin.

Some taxidermists attempt to stiffen the cartilage in deer ears and save the time and work of taking it out, by inserting behind the cartilage a piece of wire cloth, sheet lead, or linoleum, thinned down at the edges and coated with mâché. This is a time saver, but the result is not so good as when the cartilage is entirely removed. In some animals the removal of the cartilage is simple and takes but a few minutes with an expert hand, by the use of a knife and large scraper. In other animals the cartilage is tough and adheres so strongly to the skin that it must be almost entirely cut out with a knife.

After the cartilages are out, place them in cold water for half an hour to plump. These serve as models for making duplicate artificial cartilages. A quick method of duplicating them is to lay the soaked, wet, cartilage on a piece of cardboard and trace around it with a pencil. Cut out the cardboard, and using it as a pattern, with shears cut out two pieces of wire mosquito netting. One pattern answers for both ears, as by turning over the netting they are reversed. Bend and model the netting into the shape of the natural cartilage, imitating the grooves and general form. Hook a piece of fine wire into the netting cartilage near the tip and dip the whole thing into shellac, mixed and thickened by stirring in

ry plaster, until a good heavy coating is formed on the dipped netting. After dripping into the shellac vessel a while, hang it up and allow it to dry. The lower half may be dipped a second time if greater strength is desired on large ears. This makes a very good artificial cartilage and one that will not soften to any extent after it is inserted in the wet skin. The old method was to cut out a piece of thin sheet lead and hammer and model it into the shape of the natural cartilage. This takes too much time and is much heavier than necessary.

The most accurate cartilages are reproduced by casting, as follows: Remove the natural cartilages and soak them in water for half an hour. Lay them upon a piece of board, concave side up, and build around them with clay, modeling the tips evenly all around. Oil the inside with stearine and kerosene, and make a plaster mould of the inside of the ear cartilage, leaving the edges of the mould quite thick. When set, remove the cartilage and trim the edge of the mould all around flat across, leaving a clean sharp edge on what is now a convex surface. Wet or dry, paint the mould with stearine and kerosene and it is ready for casting, as in Plate XXII, Fig. 3.

Cut out two pieces of cheesecloth for each ear, large enough to cover the mould and lap over the edges all around. Wet them with water and wring them out. Unfold and lay one piece flat upon a piece of board, tin or glass, and with a modeling tool, spread the cheesecloth evenly all over with good strong glue papier-mâché containing a very little white lead and linseed oil to waterproof it. What is to be the base of the cartilage should be more heavily coated than the tip. Lay the second piece of cheesecloth on top of this and with the modeling tool smooth and grind it down, seeing that no wrinkles exist. Lift up the two with the mâché spread between them, lay them on the mould, and with the fingers rub them down evenly all over, allowing the edges to overlap on the sides of the mould. If the cloth is too large, trim the edges with shears. In an ear cartilage made thus, the tip is in danger of being broken in adjusting it to the ear, and to avoid this the tip is strengthened as follows: Cut out a V-shaped piece of wire mosquito netting, using a tin pattern as shown in the plate, and model and bend it so it will lie flat on the tip of the mould. Spread it with soft mâché, lift up the tip of the upper piece of cheesecloth, lay on the piece of net-

ting and cover it with the cloth again and model and smooth it. When dry, this reinforces the tip. Set the covered moulds aside and remove the casts when dry, trim the edges with shears and when bone dry, with a flat file, work the edges down sharp and even. Paint the cartilages with warm wax and carbon tetrachloride to waterproof them and when dry, give them a good coat of shellac. These make accurate cartilages and are very light and strong, as shown in Plate XXII, Fig. 3.

In putting in the artificial cartilages, it is necessary that the natural cartilage be removed clear to the tip and edges all around. After poisoning, and painting the inside of the ear with glue and glycerine composition, the ear is turned right side out, and a small ball of soft mâché dropped inside and worked down to the tip. By squeezing the ball of mâché between the two skins, with the fingers, it is mashed and distributed evenly and thinly all around the inner edge of the ear. A second ball, or as many as desired, may be thus used until the edge is filled all around. The artificial cartilage is then painted with warm, hot glue mâché and fitted into the ear. To hold the cartilage in place, a few stitches may be taken through the ear at different points and the ends of the thread tied together on the back. In some thinly-haired ears, a piece of netting may be bent and fitted to the inside of the ear and held in place by stitching and tying with thread, thus clamping and holding in the inner skin of the ear until it is dry. This, however, is seldom necessary if the ear cartilage has not been made too large.

Some animals, like a deer in summer coat, have flesh-colored or pink ears. To try to color a dry white or brown ear and reproduce the pink appearance from the outside is a very difficult matter, as many of the white hairs are also stained in painting. To overcome this, after the ear is poisoned and glycerined, rub the inside all over with dry, red water color mixed with whiting in the proper proportion. Pink water dye answers the same purpose. This strikes into the skin and when turned right side out gives a fine transparent effect and leaves the white hairs unstained. The color is also inside where it belongs and not on the surface.

The usual method of modeling ear butts, or bases, is to insert the artificial cartilages, and then fill the whole inside of the skin of the butt of the ear with soft mâché. When the skin is sewed up on the back of the head and neck the ears are supported at the

os with a thread passing through them and tied to the horns, or a stiff pointed wire driven into the skull and bent over into a hook at the top. The ear bases are then modeled into shape. This method is not accurate and in most cases results in a baggy appearance and false modeling of the ear butts. To obviate this, it is best to model the ears upon the head in the position they are to occupy in the finished head, before the skin is put on, in the following way: Grease the ear base area of the model with lard or stearine. With needle and thread, attach a double thread to the artificial ear cartilage near the tip. Model the base of the cartilage with soft mâché and spread some upon the greased surface and press the ear in position. Support the ear by tying the thread to the horns or to a supporting wire driven into the skull, and if necessary give a pin or pointed wire through the ear base into the manikin to keep the ear from shifting. The modeling of the ear butt is then perfected. When dry, the threads are cut, the pin withdrawn, and the ear lifted off and hung up to dry. After being waterproofed with wax and carbon tetrachloride followed by a coat of shellac, the ear is ready to go into the skin. The greasy surface on the model is wiped off with a rag wet with benzine, and brushed with shellac.

In adjusting the ears, when the skin is put on, the articular surfaces of the ear butt and the model are spread thinly with soft mâché. After the opening cut on the back of the head is sewed up, the ears are posed by sliding them back and forth on the sides of the head until they are exactly even and in just the right position. The common fault in adjusting ears is that they are placed too far back and too low down on the head. A small hole may be drilled through the skin and ear base near the edge, and a pin driven into the manikin to hold the ear in place while the mâché is drying. By this method there is no guess work about the ear base modeling and when finished it is more accurate and satisfactory than if done by the soft-filling method.

Artificial Eyes.—Glass eyes are regularly manufactured and for sale by dealers in taxidermists' supplies, who publish catalogs and price lists giving the sizes, colors, and styles of artificial eyes. One of the greatest troubles with ordinary manufactured artificial eyes for birds and mammals is that the coloring is on the back instead of near the front of the eye. With a high crown the color-

ing is too far back, so that when the eyes are set, looking at them from directly in front, one sees only two balls of clear crystal glass. From the side they may appear all right. To obviate this some manufacturers supply eyes that are made flatter and with less crystal, which is an improvement with small eyes. But this can not be carried out with large mammal eyes as these would have to be made too flat if the coloring were brought far enough to the front. Consequently, the large mammal eyes ordinarily manufactured are not well adapted for use in the best taxidermic work, and the ordinary white-cornered eyes are still worse.

To take their place, clear crystal globe eyes are now manufactured for higher class work. These may be colored from the inside using the eye of the living animal as a guide. Eyes made for American deer are usually too light in color, but when globe eyes are used, they may be made as light or as dark as desired, depending upon the colors used in painting. To paint globe eyes proceed as follows: Trace and cut out a paper pattern of the shape and size of the pupil desired. In the deer and other hoofed animals this is oblong. From this, cut and file a tin pattern. Solder a short piece of stiff brass wire to the center of one side of the tin, the wire projecting at a right angle. Place the tin pattern on a piece of white newspaper and trace around it with a sharp pencil, grasping the wire with the fingers to hold the tin in place. Cut out the paper pattern with fine scissors. Another method is to lay the newspaper on a piece of glass and with a sharp pointed knife, cut around the tin pattern. If a great many were to be cut, steel dies could be used to stamp out the paper patterns.

Mix black tube oil paint with a very little white, using a small square of glass or tin as a palette. With a small artist's brush paint both sides of the paper pattern. Paint directly on the inside of the globe eye in its proper position, the general shape of the pupil, pick up the painted paper pupil with the brush tip, and set it in place inside the globe on the painted surface. When properly placed and centered, tamp it in place firmly with the flattened end of the brush handle and work out all air bubbles. Pour a little turpentine in a small saucer, clean out the brush and wipe it on a piece of dry cheesecloth. Dip the extreme tip of the brush in turpentine and clean all around the paper pupil without shifting it, wiping the brush from time to time on the cheesecloth. It is a

ood plan to allow the cheesecloth to rest on the lap, the white below acting as a reflector in looking through the glass eye. When perfectly clean all around the pupil, the eye at this stage may be allowed to dry several days, or the painting may proceed and the eye be finished at one painting, as follows: For a deer, paint around the pupil with thick raw umber tube oil color, for a space of about one-quarter of an inch. Finish out the balance of the globe with thick Vandyke brown mixed with black. Hold the eye up against the light and touch out all unfilled spots and set the eye away to dry.

When dry, before the eyes are set in the skin, stuff the inside full of crumpled tissue paper to keep the mâché with which the eye is set in the socket from coming in contact with the paint, as in drying the mâché is liable to pull the paint loose. For veining, put on the ground color and allow this to dry. With a pointed instrument, scratch the veining through the dry paint, and paint over this with the color the veinings are to be made. Globe eyes are sometimes colored by painting on a plaster core made to fit the inside of the globe. For depth in the pupil, a hole the exact size and shape of the pupil is cut in the core. In some instances, for special exhibits, artificial lights have been arranged inside such eyes.

Putting Skins on the Models.—As before stated, skins may be tanned and relaxed, or the raw, salted, beamed and relaxed skin may be placed directly on the model. I have used both methods, but most skins shrink more or less in tanning and they are then troublesome to put on the model owing to the tightness of the fit. If the model be kept undersize, tanned skins work all right, but haired skins such as deer, elk, antelope, etc., should never be drummed in tanning, as drumming produces whorls or cowlicks in the hair and I have never found any method of removing them. Wetting the hair and combing it has little if any effect. I prefer mounting the raw skin. After beaming, put the skin in warm water containing a little borax and soap shavings, and let it soak half an hour or longer, until thoroughly relaxed. Drain the skin and roll it up overnight, hair side out so no part of the inside of the skin will become dry by exposure to the air.

Paint the skin all over the inside with B. A. Hide Poison diluted with water, or white arsenic boiled with sal soda (sodium arsenite) and water. Follow this painting with another of good strong hot carpenter's glue cooked in water, mixed half and half

with glycerine. This holds back the skin from becoming bone dry. Paint the model all over with strong hot glue mixed with wallpaper or wood pulp and enough dry plaster so that it will paint evenly when hot, chill in a few minutes, and become rubbery. It is essential that the mâché coating chill and become rubbery, otherwise it will brush off when the wet skin comes in contact with it and be pushed into the depressions of the model, leaving none on the high spots. If the mâché remains soft and mushy and does not chill, it is a sign the glue was too thin. When all coated, the model is ready for the skin.

If the legs have been taken off the model to avoid seams in the skin, slip each leg separately into the skin where it belongs, like drawing on a stocking. If a horned animal, the horns are taken off so as to allow the unopened neck skin to slip over the skull. Two wooden horses several feet apart are spanned with two pieces of two-by-four scantling, or joist, padded with burlap, one scantling coming just behind the elbows and the other under the belly just in advance of the hind legs, to keep the model from slipping forward or backwards. The horses should be high enough for the feet to clear the floor. While an assistant steadies the model, the skin is drawn over the head and down on the body. The projecting dowels and the articular surfaces of a front leg are painted over with warm mâché and the dowel entered in the upper dowel case. The leg is pushed up into place and the pin driven through from the outside by slipping the skin around, and the end snipped off flush. This keeps the leg from slipping out of the dowel case above. With the fingers, soft mâché is then spread all around the joint and the excess wiped off so as to leave a smooth even joint. The other front leg is similarly treated. Then one hind leg after the other is adjusted, the pins being driven in and the joints smoothed with mâché. The pedestal is then placed underneath and the animal lifted off the horses, let down upon the pedestal, and the nuts tightly screwed up underneath. The horns are next screwed fast to the skull and the joint wiped with soft mâché. The artificial ear cartilages may be put in place before the skin is put on the model, or if the skin has been opened on the back of the head and neck, these may be put in afterward.

Owing to the rubbery mâché coating on the model and the glycerine composition on the skin, the skin slips around easily on

model, and is adjusted all over, care being used that the back centered; and if the animal have any distinct markings or patterns—as are found in many African antelope—see that these are their proper places and evenly balanced on both sides of the animal. The white pattern on the inside of a deer's leg, for example, belongs on the inside and is not seen from the outside. The articular surfaces of the modeled and dry ear butts are painted with fresh mâche, and the ears posed and held in place with threads running from the tips, and tied fast to the horns or to a stout bent wire driven into the top of the head. The joint all around ear butt is then smoothed with mâché introduced with the fingers through the neck opening in the skin.

The opening cuts in the skin of the back of the head and neck and that along the under side of the body and tail are then sewed up using three-cornered glover's needles and double number 25 thread, rubbed with wax. Being cornered and sharp, glover's needles cut their way through a skin where a round needle would not enter. In default of three-cornered needles, grind a round needle on a fine emery wheel and make it three-cornered, with sharp cutting edges. By pulling and slipping the skin around on the model, it is adjusted all over. The skin of the lips is pushed up with a thin-edged modeling tool into the slot made for its reception, and the skin of the nostrils is properly placed and the nostrils packed with newspaper to hold the skin in place while drying. Should any holes exist, the edges are brought together and pinned up driving heavy pins into the model. Bullet holes sometimes have the hair around the hole cut off with the entering bullet. These could be cut out, extending the cuts, with the lay of the hair and cut crosswise of it, beyond the hole on either side, thus changing a round hole to a long slit. The edges are then pinned together. Some holes may be sewed from the inside before the skin is put on the model.

Should there be too much skin at any point, this may be worked together, and the small wrinkles flattened out and made to "take up" by working them back and forth with the fingers and palm of the hand. Air bubbles are punctured with a sharp flat awl, driving it through the skin and allowing the air to escape. If wrinkles are wanted at any point, such as in the face or neck or behind the ears, soft mâché is inserted beneath the skin and the desired

wrinkles formed with a modeling tool or putty knife. Soft warm mâché may be injected underneath a skin at any point by using an automobile grease gun with a piece of rubber tubing attached to the nozzle, the whole being kept warm by immersion in a bucket of hot water. The tubing may be inserted in a small cut made in the skin, or a few stitches may be taken out in the opening cuts; the tubing worked under the skin to the desired point and the mâché injected. Soft mâché may also be placed on the model at the desired points before the skin is put on, or before the neck or belly cuts are sewed up.

In setting eyes, the sockets are filled with soft glue mâché. The globe eyes are stuffed full of crumpled newspaper and set in place using a small scraper to adjust the lids and model the lid markings. With an artist's brush and a cup of water, clean off the mâché from the eye and the lids and perfect the modeling, being careful that the eyelashes project downward rather than upward. With the brush, wet with water and dry lamp black, paint the lids to give the proper expression.

A hole is drilled through the point of each hoof and a small nail or stout pin driven through it into the pedestal to hold the hoof in place. The feet are then filled with glue mâché and chopped tow, mixed. A small pusher is used to force the tow mixture into position to plump out the skin, and the foot modeled into shape. The skin at the backs of the feet is then sewed up. Another method is to model the feet in mâché and tow first by tying the skin and feet to the leg above to keep them out of the way. The feet are then brought down and adjusted and the pin driven into the pedestal. When nearly sewed up, the modeling may be perfected with the pusher.

In order to make the skin dry fast to the model and also to smooth the hair, an electric heater is used. The small portable circular heater on an upright stand, known as the "Majestic," is suspended on a hook fastened to the end of a wooden arm with a hole bored through the other end, which slides up or down on a long upright pipe set into a flat board base or standard for support. The arm, with the heater suspended from the end, may be raised or lowered and holds fast without dropping wherever placed. The heater is suspended at different heights, a foot or so distant from the model, and is shifted from point to point as the skin and under



THE SPECIMEN COMPLETED

ying mâché become sufficiently heated and softened. The hair is combed and brushed out with a wire brush, unless the hair be naturally kinky or curly, like a bison. Such hair should not be combed, but when dry should simply be beaten with a long-handled brush and a flat flexible stick. The warm skin is smoothed further by hammering it lightly with a flat stick or a wooden mallet. To hold the skin in depressions while drying, stout pins are driven through the skin into the hard model. Furrier's "blocking pins" of various sizes, procurable of dealers in taxidermists' and furriers' supplies, should be used. Iron nails will not answer in most cases as they are liable to rust and stain the hair. If the hair be long enough to conceal the pin heads, drive the pins all the way in and allow them to remain there. If the hair be short, drive the pins part way in until the specimen is dry. Then twist the pin around with a pair of flat pliers and withdraw it. The foreleg tendons and other anatomical details may be brought out by pinning strips of white felt covered with pieces of soft rattan into the depressions. Lay on a strip of felt, cover with a piece of rattan and drive pins through both into the model, thus clamping the skin tightly to the model. This is adapted only to short-haired skins. On such skins, felt and fine-mesh wire cloth is also used in the same way. It is a good plan to remove all pins at the expiration of a day or two, smooth out the skin, and drive in pins again wherever they are required to hold the skin down.

The depression at the hock joint is held in place by covering the skin on both sides with a thick layer of tow. Wooden blocks, previously cut, are fitted to the depression. These are adjusted over the tow cushion and screw clamps put on and screwed up tightly to hold the skin in place, the skin and underlying mâché being well warmed before the tow is put on. In a day or two the clamps are removed and readjusted so as to be sure that the skin is clamped firmly all over to the underlying modeling. When completed, the specimen is set aside to dry. It should be examined occasionally for a few days to see that the skin is drying properly and not drawing away from the depressions.

Finishing.—When the specimen is perfectly dry, cut off or pull out all pins that show through the hair, brush well with a wire brush, and wipe off the hair with a rag dampened with coal oil to gloss the hair. Clean around the eyes and nose with a scraper

and small stiff brush and the specimen is ready for finishing. Plenty of time should be given to finishing. I have seen many well mounted specimens which looked very ordinary because of the lack of finish. Be sure the glass eyes are well cleaned and polished. The eyelids should be carefully painted with hot wax containing a little Vandyke and black oil color. After the wax is on, model it with the scraper, sometimes cold and sometimes heated over a gas or alcohol flame. Holes may be filled by laying on a small chunk of cold wax and heating and welding it in place with a warm scraper. Large holes and the cavities of the inside of the ears may be filled by dipping pieces of cotton batting into hot, colored wax, draining them, and working the cotton into place with a brush, warmed in hot wax, and a hot modeling tool. To smooth the wax, paint it with turpentine and rub it with the end of the finger. Wax that has chilled in hair may be removed by wetting the part with turpentine and working out the wax with the finger nail and scraper. The finger nail is very useful in planing down a wax surface, before and after turpentine has been brushed on. The bare space on the noses of some living animals looks wet. To reproduce this, wax over the painted dry skin, smooth it with turpentine and the finger, model the pitmarks with the point of the scraper or pointed match stick, and paint with white shellac. Shellac should also be painted on the waxed and colored eye lids and the insides of the nostrils. The tips of sea lion flippers may be waxed and modeled, too much wax in the short hair being absorbed by covering the spot with a piece of dry blotting paper and holding a hot modeling tool against the paper for a few moments. The heat liquefies the underlying wax and this is absorbed by the paper. Turpentine and a rag are then used for the final finish.

Skins that are thinly haired, like the faces and under parts of some monkeys, so that the colored skin shows through the hair, may be colored blue or pink from the inside, as already directed for coloring the inside of a deer's ear. This color may be varied by painting the outside of the skin when dry with tube oil colors and turpentine. Dry plaster is then stippled on and brushed out, the plaster scouring and removing the paint from the hair. Dry water color paint is sometimes mixed with the plaster.

The colors of haired skins may be changed or intensified by spraying or painting the hair with oil color and wiping it lightly

with a soft rag. Painting the hair on the face will greatly intensify and improve a mounted deer head, and old mounted and faded heads or specimens may thus be renovated and sometimes brightened up to look "as good as new." Whites may be whitened, and dark hair darkened, thus producing the original contrasts in color. Neck and leg seams, and spots from which the hair has been accidentally removed, sometimes require "doctoring" by "setting," or gluing on, hair. Hammer the seams to flatten them, and wax them over. Then glue on hair taken from another skin or possibly taken from another part of the same skin where it will not be missed. If the form and texture be matched with the surrounding hair, the color may sometimes be matched by painting it. With a pair of small tweezers or forceps, grasp the bunch of hair that is to be transplanted, and with small scissors cut it loose from the skin. Wet the bases of the hair with equal parts of liquid glue and shellac, mixed, this mixture being applied to the hair with a flat piece of wood. The hair that is grasped in the forceps may then be arranged with a fine needle set in a wooden handle. Paint the surface where the hair is to be applied with the mixture and set the hair in place and arrange it with the needle. Rubber cement, to be purchased in tubes from dealers in auto supplies, also works well in setting hair, in place of glue and shellac. Much skill and patience are required to set hair successfully and to conceal or camouflage the spot so it matches the surrounding hair and cannot be detected.

Horns and hoofs should be wet with a brush or cloth and well cleaned of all spots or specks of mâché or clay. Then brush them over with a light coat of boiled linseed oil and wipe off the excess with a dry rag. Never varnish hoofs or horns, unless the former are to appear as if wet.

Hairless skins, like hippos, rhinos, elephants, and alligators, should first be shellacked and dried. Oil colors are then painted on, and powdered clay, dry colors, plaster, or a mixture of two or more of these, stippled on the wet paint, rubbed, and brushed off. To make a pink color in creases or depressions, paint on the darker or surface colors and when this is dry, paint with the pink color and rub and wipe this off with a cloth. This leaves the pink color in the crevices where the cloth fails to remove it in wiping.

Open mouths will require to be finished in wax. The gums and

roof of the mouth are painted with hot pink wax, coat over coat as it cools, and modeled with a scraper until the proper form and modeling are attained. To color the wax, heat in the water bath white wax, two thirds, and paraffine wax, one third. When melted, dip out a large spoonful and with a round-ended flat stick grind and stir in tube oil colors—vermilion and alizarin crimson—until the colors are thoroughly ground into the wax. Put the spoon in the hot wax and stir in the color. Test for color by pouring a little on a piece of paper, and for tongues by dipping a fluff of white absorbent cotton and allowing it to cool. As much color as desired may be added in this way. Never put the paint directly into the wax as the bulk of the color will settle to the bottom and remain there. Another method of coloring wax is to dissolve the paint in a minimum of carbon tetrachloride, where it may be kept in solution indefinitely if tightly stoppered or corked. To color a batch of wax, pour in as much as desired of the colored solution. Oil dyes dissolved in benzine or carbon tetrachloride give a transparent wax—much more so than wax and oil colors.

Dark-colored wax is painted on the lips and blended with the pink wax where the two join. With a heated or a cold scraper, model and clean off the wax around the teeth and model and perfect the grooves in the roof of the mouth. More hot wax may, of course, be painted on at any time, or wax may be cut off as desired. Wax may be smoothed and polished by rubbing it with the side of a round needle set in a handle.

To make a tongue, dip a long wisp of absorbent cotton into the pink-colored wax and pin it up to the edge of the table so it hangs free, and allow it to remain there until cool enough to handle without sticking to the fingers. Then with shears, trim it to about the required size. Fit it into the mouth to try it out for size, and model it into shape with the fingers and try it out again. Repeat this until the tongue is satisfactory. If the tongue gets too cold in the modeling process, warm it gradually over a gas flame and remodel it. Fasten a wire to the back of the tongue and fit it into the throat. Wrap the wire with a wad of absorbent cotton and dip the cotton and base of the tongue into hot wax and put it quickly into place in the mouth. To fasten it more firmly, hot wax may be painted underneath to weld it fast. The papillae of the rough upper surface may be represented by digging into the

tax with the point of a scraper. This may be done before the tongue is inserted, if desired. If the teeth require cleaning, paint them with muriatic acid and at once rinse this off by painting with water. If left on, this acid will corrode the enameled surface of the tooth. This process may be repeated until the teeth are as white as desired. When dry, paint the inside of the mouth and the teeth with white shellac to represent saliva.

In finishing, hard fully-matured deer horns seldom require anything more than washing off with a wet rag, oiling with linseed oil, and a final wiping with a dry rag. Horns that are shedding their velvet are generally ragged and unsightly and are best treated by removing the velvet entirely and staining the horns in imitation of hard horns. Soak them in water several days until the velvet skin loosens, when it is peeled, scraped and brushed off clean. Allow the horns to dry and sandpaper them smooth at the points. Paint with thin white shellac and allow several hours for drying. Paint with white, raw and burnt umber mixed with turpentine, and rub off with a soft rag. Stipple on raw and burnt sienna lightly and again wipe and stipple with a dry rag, followed by a little Vandyke brown at the bases. Use a pair of hard horns as a model for color, and use the paints more as a stain than as a solid color, using the wiping rags freely. The dry horns are very porous and if the preliminary coat of shellac be omitted, the first coat of paint will sink into the dry horn surface and it is impossible to remove it.

Deer horns in the soft velvet, unless they be treated with some preservative, become very odoriferous while drying, and if the horns are not watched and protected, the maggots will sometimes get into and destroy the velvet. When dry, they generally shrivel and lose their color, and present an entirely different appearance from the full, plump, velvety horns on the living animal. Painting with arsenic water and a little formalin will keep off flies and in time the velvet will dry down, but will be more or less shriveled. To prevent shriveling they may be treated as follows: Puncture the tips by driving in a long flat awl and twirling it around to loosen the tissues of the horn tips. Drive in a few long wires and, with cords attached to the wires, suspend the horns over a wash tub. For a week, or until the soft tips are firm and hard, paint, and follow with a dipper several times a day, with the following solution:

Water	1 quart
Glycerine	2 quarts
Salt	1 pound
Alum	1 pound
White arsenic	1 pound
Formaldehyde	½ pint

Rinse off with warm soapy water, then paint with hide poison or strong arsenic water. While drying, brush the hair with a stiff hand scrubbing brush so the hairs will stand out and not dry matted together. When dry, color by spraying with oil colors thinned down with turpentine or benzine. If a number of pairs of fresh velvet horns are to be preserved in a season, a quantity of the solution may be made up and the horns—either sawed off or attached to the skull—immersed and pickled in the solution instead of painting it on. This is of course better than painting but requires a greater quantity of the solution which is expensive by reason of the quantity of glycerine it contains.

Mounting Intermediate Sized Mammals by the Direct Excelsior Manikin Method.—For animals similar in size to a coyote, the direct excelsior and papier-mâché method is useful. This is the same as the excelsior and clay manikin process, except that instead of coating the wrapped excelsior model with soft clay, papier-mâché is used and allowed to harden before the skin is put on, in the same general way as the direct modeling method of mounting a deer head described in the present chapter.

By this method, the cleaned and shellacked skull, pelvis, and leg bones are stapled fast to a thin center board which is cut out to the general outline of the body. Excelsior is then bound on with thread, working out the general form. The manikin is then completed by covering the excelsior with soft mâché and modeling the details of the external anatomy. When dry, the model is water-proofed and shellacked, and the flat skin adjusted and sewed up the backs of the legs and under side of the body and tail. This method is a very simple one and is well adapted for long-haired or furred animals of intermediate size, where the seams on the legs are concealed by the thick fur and the specimen is not so large that weight is a consideration. For short-haired animals, dowel cases may be inserted in the legs, along the sides of the bones, before the modeling is done, and, when dry, the legs sawed off as already

described. Brass tubing may be used for dowel cases and pieces of iron rod for dowels.

Mounting Large Mammals by Casting Entire Carcasses in the Flesh.—In his book, *Artistic and Scientific Taxidermy*, the author, Montagu Browne, described and figured in 1896 a method of casting the carcasses of dead animals and from the resulting moulds reproducing paper manikins upon which the skins were afterwards mounted. The idea was all right, but the chief fault with the method as described lay in the fact that the carcasses of the dead animals cast were laid flat on their sides and posed, and first one side cast and then the other. The paper casts, when removed from these moulds, were badly posed, distorted, and flattened; and without restoring the lost and misshapen external anatomy, the casts were nearly useless as a manikin upon which to mount a skin and preserve the true form of the living subject. Had he stood up and supported the fresh carcass in the exact attitude he wished the finished animal to assume and then modeled upon the carcass in clay and restored the sunken and relaxed exterior muscles before casting, the result would have been different.

I have successfully mounted several sea lion pups, bringing out all the natural folds and wrinkles in the skin by posing the dead animal, greasing and slicking down the hair, and casting the animal. The specimens were posed standing on a table, with a stout screw eye driven into the top of the head and the head suspended at the proper height with a cord fastened above. The flippers were placed as desired and the animal carefully posed as in life. The hair was then painted all over with clay thinned with water, oiled with stearine and coal oil, and cast in plaster two-piece moulds. The pups were then skinned as usual. Later, papier-mâché casts were run out, the modeling perfected on the cast manikins, and the skins adjusted as usual. The results were entirely satisfactory. If the posing be carefully done before the carcass has had time to float, proper proportions are certainly secured.

A group of five summer deer, all lying down, was done by this process. Animals lying down lend themselves readily to this method, as only the head and neck need to be supported. The deer were skinned before casting, and the skinned carcasses posed, using photographs of living deer as guides. When mounted on per-

fectured cast models, the result was absolutely satisfactory in every respect.

A harbor seal lying on a rock was done in the same way, before skinning, with excellent results, the whole head and nose being cast at the same time and incorporated in the completed model. By this method great accuracy may be secured if properly done, and the time to make a clay model for casting is saved; but it is not always that the fresh carcass of a large animal that is in good condition is brought to the taxidermist. The method also has its limitations as regards the size of the animal. Too large a specimen would sag and be too unwieldy to handle in certain poses, but for mammals from the size of a fox up to a deer, the method is a good one, and many people could do much better work by this process than by modeling.

Some people would say at once, "Oh! But that is not Art, like painting or sculpture! That is like casting bricks or bolts." Neither is casting a fish or a reptile that is to be placed on exhibition "Art" in that sense. Objects in a museum are exhibited to tell a story and to show what a certain creature looks like. The better and more realistically that creature can be imitated and shown, no matter what the material be composed of, the better story is told. If the dead body of a coyote can be posed and cast and the skin fitted to that cast and be made to represent a living coyote better by that method than by any other, then I say by all means *cast the coyote's body*.

For these same reasons, large hairless mammals, such as elephants, rhinos, and hippos, are best represented in the form of models, painted as in life. To skin and mount successfully the skin of a huge elephant is a herculean and expensive task. The skin when dry must be painted so that what is actually seen is the paint. What difference does it make what is underneath this paint, whether it be dry skin fiber, papier-mâché, or any other composition? Large marine mammals, fish, reptiles, and plants are thus reproduced and represented in our museum halls and no questions are asked. Why not the pachyderms also? If the elephant can be best represented as a museum exhibit in the form of a model, by discarding the skin and saving a lot of hard work and money, by all means do it. Furthermore the texture of the surface of the dried skin is different from that in the plump living animal, although by certain

processes of tanning the skin texture may be made to approach that of the fresh hide. In most elephants that are mounted, much of the epidermis is apt to be lost in the preparation of the skin in the field. This must be restored with some other material in the mounted specimen. Why not restore it all, even to the tusks? Why bury one third of the length of a pair of valuable genuine ivory tusks in a mounted skin when good colored casts of the same tusks would answer every purpose so far as public exhibition is concerned. If a group of elephants is to be exhibited as a popular exhibit, the more lifelike those elephants can be made to appear, the better the exhibit, no matter of what material they may be constructed; and this statement holds good with all exhibits in natural history museums. For scientific purposes, the actual specimen is, of course, desired, but that is another matter.

Mounting Heads.—The process of skinning a horned head designed for mounting as a trophy is essentially the same as already described for skinning the head of a whole animal. In skinning, the skin is circled with the knife around the base of the neck and the opening cut runs along the top of the neck to a point a little behind the horns in the center of the back of the head, where it divides into a Y, the ends of the Y terminating at the base of each horn. In a very short-haired animal, the center cut along the back of the neck may be reduced to a minimum in length and only a short Y just large enough to disjoint the skull in skinning, be made on the back of the head. The neck skin may then be inverted or turned inside out. This of course necessitates lifting off the horns in mounting, in the same way as mounting a whole specimen with closed neck.

In cutting off heads for mounting, a common mistake is to cut the neck too short. The skin should be cut back to the shoulders and brisket. If not wanted for mounting, the excess may be trimmed off and discarded. Another common mistake is to cut the neck skin off too short on the lower side and leave it longer than necessary on the top. Always cut low down on the brisket and thus allow plenty of skin for mounting. If the head is to be mounted with a long neck showing the shoulder points, cut back a few inches beyond the shoulders and well back on the brisket.

Always save the entire skull and lower jaws for mounting. Clean off the bulk of the meat, remove the brains, wash out the

cavity, and allow the skull to dry. Salting or soaking the skull in brine will do no harm. Boiling the fresh skull in water for half an hour or so to make it clean easier is all right. Ordinarily, dry salting the head skin, the "scalp" or "cape," as it is usually called, and drying it out before shipment is all that is necessary. In other respects, scalps are handled the same as entire skins. If several heads are collected at one time, they should be numbered in duplicate, one number being attached to the skull and a corresponding one to the scalp belonging to the same specimen. Flat wooden tags numbered or lettered with an indelible or ordinary black lead pencil answer every purpose.

If but one head is to be mounted, this is perhaps best done by the direct modeling process, to be carried out in the manner to be described. A small black-tail deer head has been selected as the example. Procure a block of clear pine wood about 2 x 3 x 6 inches long. With a hack saw, make two parallel cuts the thickness of the block in the underside and back of the skull, and with a chisel and mallet remove the square chunk of bone. Chip off the projecting bone on the inside of the skull so it is smooth, and fit the block inside by sawing the end on a bevel and rounding it slightly with a draw-knife. Remove the block and bore a $\frac{1}{4}$ inch hole through it, lengthwise. Insert one end of a piece of $\frac{1}{4}$ inch soft iron rod about two feet long, turn over the end and staple it fast underneath the block so it is firm and rigid. Place the block in the skull, with the rod attached, and drill holes through the skull into the block for the reception of wood screws, which when inserted hold the skull rigidly on the rod. Drill a hole through the angle of each jaw and drive a nail through it into the block. A small wire in the front of the jaws twisted around both mandibles holds the jaws in place. Drill a hole in the top of the back of the block and another underneath between the jaws. Insert a piece of number 10 soft wire, about like ordinary hay baling wire, into the upper hole and staple it fast. Place another wire in the hole underneath, bend it over, and staple it also. Clamp the end of the neck rod in the vise and bend the wires so as to outline the front and back of the neck.

Pose the head, straight or turned either to the right or left as desired. The length of the neck must now be determined. This is governed in most cases by the length of the neck on the scalp which

companies the skull. Unless the shoulder points are to show, it is best not to make too long a neck. A well-balanced mounted head should have the neck about the same length as the head, from nose to occiput. The size and backward trend of the horns must also be taken into consideration. As the head is to hang on a wall it must be mounted so the rear horn-tips will clear the wall. With a plumb line—or a nut fastened to the end of a string—plumb the base of the neck by holding the string at the end of the horn tip which projects farthest back and marking off on the neck rod with a piece of chalk the spot where the string crosses. There is seldom any difficulty in posing small horned heads as these give plenty of latitude, but large horned heads, like the moose or wapiti, require that the plumbing be accurately done in order that the neck may be made short enough for the scalp to cover it, and at the same time not so short that the tips of the rear points of the horns will not clear the wall. It is sometimes necessary to throw the nose down farther than is desired in order that the horn tips will clear. If the head is to hang on a post, this precaution is not necessary. Having marked off the neck length, clamp the rod in the vise where marked with the chalk, and with a piece of pipe that slips easily over the rod, bend the rod at a right angle and twist it roughly into the form of a circle, as shown in Plate XXI, Fig. 1. Clamp the circle in the vise, pose the head, and adjust the neck wires accurately, using as a guide, measurements or a paper tracing previously taken from the neck of the dead animal.

Fold a piece of heavy brown paper and rub the fingers across the fold so as to crease it tightly. Make a pencil mark on one side of the crease, hold the folded paper against the wires so the pencil mark comes even with the base of the upper wire, and mark off on the crease the point where the lower wire crosses it. This gives the length of the neck board. With a pencil, mark off the shape of one half or side of the neck on the folded paper, and with scissors cut through both thicknesses of the paper, following the penciled outline. When unfolded, the paper presents an evenly balanced neck-board pattern. Lay the pattern flat on a piece of one-inch clear pine board and trace around it. With a keyhole saw or draw-knife, or both, cut out the board. Adjust it to the ring of the neck rod so the ends of the neck wires touch the top and bottom of the board, and trace around both sides of the neck rod

ring with a pencil. Drill holes opposite each other at several points on the penciled ring, and pass number 10 wires through from the back side and hammer them flat so the wire is driven into the wood flush with the surface.

Adjust the circular neck rod and twist the wires over it firmly with the pliers. Place the lower end of the neck board in the vise, give the final posing to the head; and staple the rear ends of the neck wires fast to the neck board, cutting off the ends flush with the back of the board. A square board, somewhat larger than the neck board, is screwed fast to the back of the latter, and a row of tacks driven into the edge of the neck board all around, the tacks being driven only about halfway in to serve as attachments for the thread in wrapping or building out the neck. The head now appears as in Fig. 1.

Fine excelsior, or wood fiber, is sprinkled with water to give it flexibility, and is bound on with number 25 linen thread, by wrapping the thread around the neck and looping it over the tacks. The lower neck wire is pulled out of the staple at the rear end and bent up out of the way, or it may be cut off altogether unless wanted to serve as a guide in building out the neck, and cut off later. To make the excelsior fit snugly around the neck board, loop the thread over the tacks wherever necessary to bind down and hold the bunches of excelsior in place. Add more excelsior wherever needed until the neck and rear part of the skull are full and smooth, minus the windpipe. This is the last thing to go on and is made by winding a roll of excelsior long enough to reach from between the jaws to the bottom of the neck board. This is wound firmly with thread and fastened on by wrapping with thread at the upper and lower ends only, as shown in Fig. 2. Drive the tacks all the way in and snip off stray stringers of excelsior with the shears.

Paint the excelsior-covered model with water and give it a stiffening coat of water, wood pulp, and plaster mixed. This soon sets and gives a firm foundation for modeling. Papier-mâché is made up with water, wood pulp, a very little liquid glue to hold back the mass from setting, flour paste, a little linseed oil, gum arabic, plaster, and ground cork or fine sawdust. The whole head and neck are first coated and smoothed all over, using a small trowel or large modeling tool for the purpose. The nose, lips, and cheek muscles are carefully modeled, and when about half dry, with

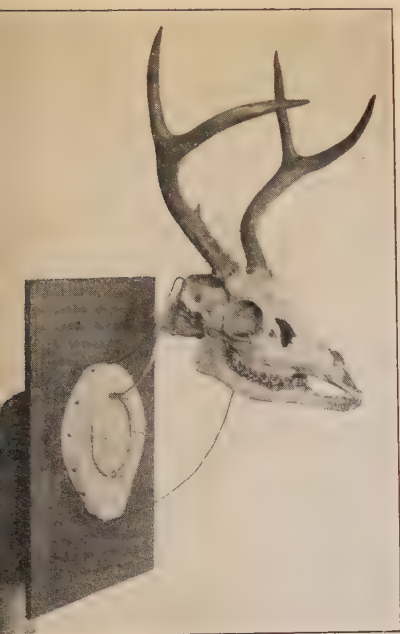


FIG. 1.—The framework completed.



FIG. 2.—The framework bound with excelsior.

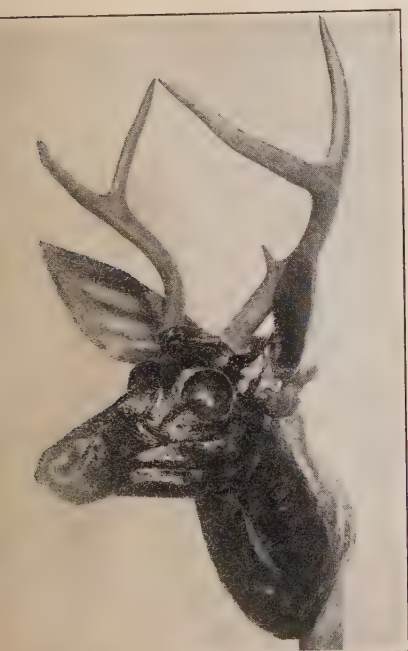


FIG. 3.—The completed model.



FIG. 4.—The finished head.

MOUNTING A DEER HEAD BY THE DIRECT MODELING METHOD

a knife and small scraper, work a slot between the lips all around the mouth for the split skin of the lips to tuck into. When dry, the model is rasped and sandpapered and given a coat of white lead paint, or wax and carbon tetrachloride to waterproof it, and finally a coat of shellac. After the ears are modeled on, the head appears as in Plate XXI, Fig. 3, ready for the skin. Fig. 4 shows the completed head.

If a number of heads of the same kind and size are to be mounted for different persons, the time taken to model each head separately may be shortened by making a clay model of the head, neck, and nose; casting it, and from the resultant moulds making as many duplicate casts as may be required. One trouble with this method is that one head looks very much like another and individuality is apt to be lost. However it is a time saver, and also enables the custom taxidermist to have a lot of head casts of different sizes and poses ready at the beginning of the deer season. When the heads arrive for mounting, the horns are simply sawed off the skull, screwed fast to the proper sized cast, and the skin shaved down and adjusted to the model.

To make a clay model, proceed with the framework and excelsior process as just described, and shown in Plate XXI, Figs. 1 and 2, except that the horns are sawed off as in mounting large horned mammals, leaving the top of the modeled head flat for attachment of the horn plate in the cast. In place of modeling the excelsior-covered manikin with papier-mâché, soft pottery clay is used and all the details of the nose and face worked out, using linseed oil with the clay and smoothing by dipping the fingers in the oil. When the modeling is completed, the clay walls for separation of the sections of the mould are arranged as usual. Stearine and coal oil are painted on thinly, and a plaster mould made in three pieces, the third piece fitting between the lower jaws as shown in Plate XXII, Fig. 1. After casting, the clay model may be rearranged and the pose changed either to right or left, and another mould made as before, thus having on hand different poses of the same sized head.

To make a hollow cast from the mould there are a variety of methods. A light paper cast may be made by greasing the inside of the dry plaster mould with hot stearine and lard, mixed. Tear building paper into pieces and dip them into thin warm glue water

to relax. Then paint both sides of the paper with paste made up of rye flour, water, a little glue, linseed oil, and whiting cooked together in a water bath and strained. White or yellow dextrine cold, may be used instead of the flour paste with the added advantage that this will not mould nor sour like flour paste. However, the addition of a little boracic acid to flour paste will keep it from souring. After the pieces of paper have been painted with paste, they are laid into the mould evenly all over and pressed with the fingers into every line and depression. Paper of another color is torn, pasted, and laid into the mould as before, and this is followed by a third coat or layer of the color used first. The moulds are then set aside to dry, when the paper casts are taken out; the edges trimmed, fitted and wired together; cheesecloth pasted over the outside joints; and the whole, inside and out, given a painting with hot wax and carbon tetrachloride to waterproof it, followed when dry, by shellacking. When this is dry, the inside may be flowed with water, gum arabic, and plaster mixed, to strengthen the paper cast. Large casts may be reinforced inside over this with burlap spread with water, wood pulp, gum arabic, and plaster mixed. When dry, this reinforcing keeps the paper head from warping or collapsing when the wet skin is put on. One great advantage of paper heads over other products, is their extreme lightness and toughness, and on this account they are extensively used, especially in the furriers' trade.

Another method is to paste in, on the stearinated surface, pieces of thin paper towels torn into pieces in the same way as the builders sheathing paper. Wipe out the excess of paste and line it all over with pieces of damp burlap cut into squares and coated with papier mâché. This is much better than the paper process, for deer heads and, when reinforced, waxed, and shellacked, is firm and strong and takes considerably less time to make.

Still another method is to leave out the paper lining, and spread cheesecloth or burlap with papier-mâché, cut it into squares with shears, and work the pieces into the mould; and then rub more mâché all over the inside when filled, being sure that the cavities of the nose and eyes are filled. When taken out of the mould and put together, the cast may be flowed inside with plaster and paper pulp to reinforce it.

After the cast is dry, a block of wood is fitted into the inside

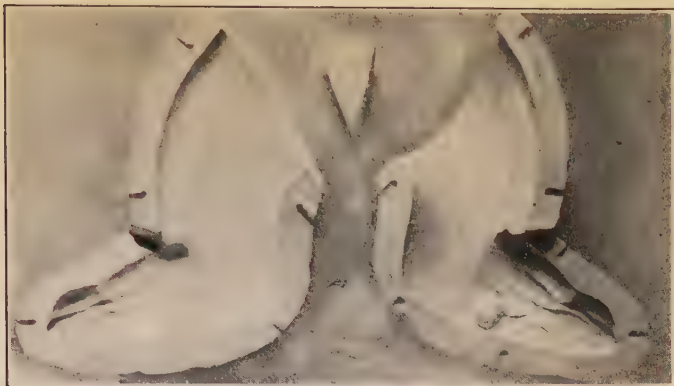


FIG. 1.—Moulds for casting a deer head,



FIG. 2.—The moulds filled and one half-cast relieved.



FIG. 3.—Mould and cast of a deer's ear to be used as an artificial cartilage.

of the top of the head and fastened in place with small nails, papier-mâché and burlap. This is to hold the screws for the attachment of the horns. A neck board is cut and fitted into the base of the neck, small wire nails driven through the edges all around into the board, and the joint at the back filled with soft mâché. After the horns are screwed upon the top of the cast head, the ears adjusted, and the whole shellacked, the model is ready for the skin as in Plate XXI, Fig. 3.

For a deer head, no neck rod or stick of wood inside is necessary for support. In large heads, wire cloth may be worked into neck moulds and mâché troweled in to stiffen it. Very large heavy horned heads may be strengthened inside by using a piece of two-by-four joist, the upper end taking the place of the wooden block used in small heads and the lower end being sawed off flush with the inside of the neck board and screwed fast to it. The scantling then supports the horns and the cast carries no weight but its own.

For the custom taxidermist, in mounting deer heads, instead of casting the ear cartilage only, the base may be modeled out and the whole thing cast in one piece in about the same time, as in Plate XXII, Fig. 3. This saves time in putting on the skins, as the ear butt modeling is all completed by process work. To model the ear butt, adjust an artificial cartilage to the head model as already described and model the butt. When dry, this will serve as a mould, or a cast may be made and used as a mould.

To get accurate ear butt modeling for a deer, this modeling may be cast directly from a dead posed head, preferably a short-haired one, as follows: With needle and thread take a stitch through the end of the ear, tie the ear forward or in the pose desired and press the ear base area into its proper shape. Paint the ear and butt all over and stick the hair down flat with clay thinned down with water. Paint strips of newspaper with the thin clay and line the inside of the ear, allowing the clayed paper to project all around the edges for half an inch. Several thicknesses may be used to stiffen the edges of the ear. Paint with stearine and coal oil, and make a plaster mould of the outside or back of the ear, taking in the ear base area. This is a waste mould and no tow nor burlap should be used to strengthen it. Keep the plaster out of the inside of the ear. When set, remove the plaster mould, oil it inside with stearine and coal oil and fill it full of plaster.

When set, chisel and break off the mould and trim the edges of the cast, filling existing holes with fresh plaster. The cast thus made forms a convex mould for making cheesecloth and mâché ears, with the ear base modeling complete, as in Plate XXII, Fig. 3.

To secure greater accuracy, if the modeling of the head and nose be difficult for the inexperienced modeler, the head of a dead deer that it is desired to mount may be posed and cast and the cast used upon which to mount the skin. Or the nose alone may be cast and perfected and this cast fastened to the cleaned and dried skull, and the balance of the head and neck modeled in the usual way. With a mould of the ear and ear butts as already described, modeling is reduced to a minimum and simple casting or mechanical process work introduced to take its place.

If but one head and neck model of each animal is required, a good method of mounting, for the preparator who can model but who wishes to avoid the mechanical details required in the excelsior process already described, is as follows: An upright board has a hole cut in it at the proper height for modeling, as shown in text Fig. 2. The skull is then suspended by cords or wires in front of the board, and two wires attached to the skull, and the other ends passed through holes bored above and below the hole in the board. The head is then posed as desired, the neck enveloped with burlap stuffed out with crumpled newspapers, these being inserted through the hole in the board. The neck is then modeled with clay, greased with hot lard or stearine solution, and covered with burlap spread with mâché, as already described in mounting entire specimens. When dry, the newspapers, burlap covering and clay are withdrawn through the hole, leaving the skull fastened on the hollow neck model. The neck is reinforced, waterproofed, and shellacked as usual, and after the head, nose, and ears are modeled, the manikin is ready for the skin. By this simple method, the tedious winding of the excelsior, and subsequent mâché modeling of the neck are avoided. Greater accuracy and lightness may also be secured and the freedom allowed for modeling renders this process of great value in mounting heads of short-haired animals such as African antelope, etc.

Heads of lions, bears, etc., designed for rugs, are generally cast in paper so as to secure lightness, these being made in the same way as already described. If but one head is desired and the dried skull

accompanies the skin, the interior of the skull is well cleaned out so as to leave only the outer shell; this is poisoned thoroughly by dipping or painting, and the skull wound with excelsior and thread and modeled with papier-mâché. When dry, a tongue is made by

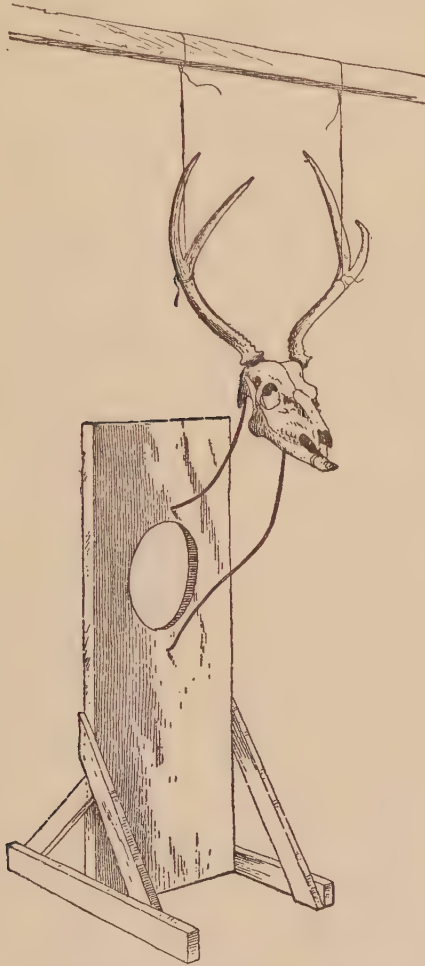


FIG. 2.—DIAGRAM OF METHOD OF MOUNTING A DEER HEAD WITH A HOLE IN BOARD.

dipping a wisp of absorbent cotton into pink wax and when cool enough to handle, the cotton is trimmed to the proper size with scissors and modeled into shape to fit the inside of the mouth. The gums are then represented by painting in hot pink wax mixed with paraffine, half and half, modeling and finishing the wax with a cold

or warmed scraper. The tongue is fastened into place with a wire attached to its base and by painting hot wax underneath, using absorbent cotton dipped in wax for greater strength wherever possible. The skin is then adjusted, and, when dry, the lips are painted with brown-colored wax and blended with the pink wax of the gums. The whole inside is then painted with shellac and then varnish, to represent the saliva.

If a number of heads of one kind and size are to be made, paper or papier-mâché casting will save time, besides giving a lighter weight head than if the bony skulls are used. If the jaws with the teeth in position have been saved, strips of the jaw with the teeth in position are sawed out with the hack saw and the strips fastened into the paper skull with mâché. If the teeth are missing, these, for a rug with open mouth, will have to be supplied artificially. Artificial whole or half rug heads for lions, wolves, bears, etc., are regularly made and for sale by dealers in taxidermists' and furriers' supplies.

The usual method of making artificial teeth for rug heads is by the use of metal moulds and celluloid. The machinery for this and the first casts are expensive, but the celluloid teeth thus manufactured are very durable and realistic. The porcelain tooth process used by dentists may also be applied to the manufacture of artificial rug teeth. For cheaper teeth, a plaster mould of the natural jaw with the teeth in place may be made, and a good quality of papier-mâché used for casting. Long canine teeth may be reinforced with wire or pieces of wood. After drying, the teeth may be painted, shellacked, and varnished in imitation of natural teeth. The lower leg bones of large hoofed animals when cleaned and bleached, sawed into pieces, filed down to the proper shape and sandpapered smooth, make fine artificial canine teeth for rug heads. Imitation whiskers may be easily made from heavy sheet celluloid by cutting it into long fine-pointed strips with scissors and rounding the edges and whitening them by drawing them through a small piece of fine sandpaper, folded together and clamped between the fingers. These may of course be colored by painting as desired and glued into holes bored in the lips of the mounted head.

Tongues may be modeled in cotton and wax, or they too may be cast in plaster moulds, as follows: Dry the moulds, soak them in boiled linseed oil for an hour, wipe them dry, and oil the sur-

faces with salad oil. Hot colored wax and cotton are then placed in the mould and when cold the two halves of the mould will relieve readily from the cast tongue. The roof of the mouth may be similarly cast in wax if desired. Another method of casting tongues in wax from a plaster mould is to paint the inside of the dry plaster with Le Page's liquid glue thinned with water and allowing it to dry. Two or more paintings may be given until a good gloss results when dry. The mould may be warmed and the hot wax and cotton put in. The whole is then placed in cold water, which soaks into the plaster, liquefies the glue and relieves the wax cast. Colored liquid celluloid may be cast in the same way, allowing each coat or flowing to dry before another is applied. When reinforced with cotton and wax, a celluloid tongue is much more durable than a wax one.

CHAPTER VI

FISH, REPTILES AND CRUSTACEANS

A large display collection of fish and reptiles is rare in museums for the reason that no good and reasonably cheap method of preparation has ever been devised. Collections of fish in which the natural skins have been used, either stuffed or on modeled forms and painted with oil colors, in most cases are miserable failures, although some large heavily-scaled fish skins, like tarpon, which have been mounted on modeled manikins, come out very well. One of the chief faults with such specimens, as found in museums, is that the skins were not sufficiently degreased before mounting, and as a result the oil has worked its way out, oxidized, turned yellow, and discolored the surface.

Plaster casts have been used to some extent, but these serve chiefly as models rather than as realistic representations of the fish themselves. To paint a cast of a fish or reptile so it will look like the real thing is a task for a real mechanic in art; and subjects with complicated and detailed color patterns are so difficult and run into money so rapidly, that most museums have fought shy of extensive exhibition collections of fish or reptiles. I have never yet seen a colored plaster cast of a fish that, to me, looked like anything but a painted cast. In life, the color is underneath the surface of the transparent skin, and when color pigment is painted on the surface of an opaque substance like plaster, the effect is bound to be different. In order to overcome these difficulties, it is therefore necessary to use the skin and to treat it in such a way that the pattern is held and the skin made transparent enough so that dyes painted on the undersurface will show through from the outside, thus producing the desired transparent effect and necessitating a minimum of coloring on the exterior of the skin. By this means some fish and reptiles may be very cheaply and realistically mounted.

Fish.—Very small fish, or delicate fish with scales so loosely attached that the skin cannot be removed without detaching or loosening the scales, must be cast. They should first be well washed with alum water to remove the slime, oiled lightly, and cast in a plaster or a gelatine mould and a celluloid cast run out, including the tail and fins. The edge of the celluloid fins and tail, after they are trimmed with scissors, may be scratched with a needle to thin them down and take away the even edge produced by the scissors. The modeling of celluloid fins and tails may be altered by applying a hot modeling tool or painting them lightly with acetone, and while soft bending them as desired. Water dyes dissolved in a minimum of boiling water and then diluted with acetone or alcohol and strained, will dye celluloid when painted on the surface. In some instances, dyes and oil colors may be painted on the inside of clear celluloid casts, and in this way a depth or translucency of coloring be obtained which is better than surface coloring. After the inside painting has been finished, the cast may be reinforced with wax or plaster or both to strengthen it, and the outer surface touched up.

Large fish without scales, or those which have the scales so well attached that the specimen may be successfully skinned, are better skinned and the skin mounted. The fish is posed as desired and painted with alum water and wiped off with a dry cloth to clean the surface, and then a couple of paintings given with formaldehyde to set the scales and skin. After oiling, a plaster waste mould is made and a plaster and gum arabic cast run out of the waste mould and set aside to dry. For large fish, a thin hollow cast of burlap and mâché may be used. The fish is then opened on the belly, or if but one side is to show as is usually the case, the opening cut may be made along the middle of the reverse side of the body, and the fish skinned with scalpel and scissors, care being taken not to cut nor injure the silver or color lining next the inside of the skin. The tail and fins are detached inside the skin and their bases well cleaned of flesh. The inside of the skull is cleaned out, the eyes removed, and the whole immersed for half an hour in cold water containing a little salt, to remove the blood. The skin is then drained and immersed in carbon tetrachloride for a few hours or longer, dependent upon the thickness of the skin, to remove the oil, and after this has evaporated, the skin is placed

in peroxide of hydrogen and water to bleach. A couple of hours is sufficient for small fish, as, if left too long, the peroxide will bleach out the silver lining also, leaving the skin a pure white. By reason of the painting with formaldehyde which has been given to the fins and skin, there is no danger of maceration in the peroxide solution. After the peroxide bath, the skin is rinsed in water and placed in glue-glycerine composition (Formula 19) and kept slightly warm, the length of time it is kept in this solution varying with the thickness of the skin. Very thick skins may remain a couple of days, and a longer soaking will do no harm. If fish fins or tails are to be distended or erected, they should be posed and clamped in position, before going into the glue-glycerine composition, as they are difficult to change afterwards.

After rinsing and scraping—with care as before not to injure the silver lining on certain fish—the skin is ready for inside dyeing and coloring, the thin dyes being painted on the inside until the desired effect is obtained from the outside. The bases of the fins and tail and the inside of the skull are filled with soft mâché, and the skin adjusted to the cast, which has been previously water-proofed, shellacked and painted thinly with glue. The fins and tail, which remain plump and flexible, are clamped between strips of cardboard, the eyes are inserted, and the fish set away to dry.

The eyes of fish are very flat and if these cannot be procured, a piece of broken bottle or electric light bulb with the proper curvature may be ground to the proper size on a power emery wheel and the glass painted and silvered as in globe eyes for large mammals. Broken or split fins are easily mended by painting them, when dry, with liquid celluloid and laying on a piece of tissue paper on the reverse side and painting this with celluloid. If celluloid is not at hand, white shellac will answer.

It sometimes happens that the eyelids, lips, and sides of the head shrink in drying, in which case these may be painted and modeled with wax and the shrinkage remedied. Silver or bronze powders are usually applied before or after surface painting with a fluff of cotton batting, but the powders should be used very sparingly as they give a hard, metallic appearance to the specimen. If the natural silver lining has been handled carefully in skinning, but little outside silvering will be necessary.

Another good method of mounting fish, where but one side is

to show, is to make a plaster waste mould of the fish, after painting it with formaldehyde, as before; the mould to include the head, fins, and tail. The fish is then taken out of the mould and skinned and treated as already directed. The skin is then placed in the mould and all wrinkles worked out. The fins and tail are pinned in position on the mould, and the inside of the skin filled with plaster and gum arabic. A block of wood, previously soaked in hot paraffine to waterproof it and keep it from swelling with the surrounding moisture, may be placed in the center for the attachment of screws to support the specimen, if it is to be mounted upon a panel. Liquid glue may be used to glue the skin in the dry mould and when the skin is filled and dry, the mould may be placed in water to relax the glue, the waste mould broken away, and the fish relieved; or if a flexible fish or reptile be desired, glue-glycerine formula Number 11 may be used as a filler instead of plaster and gum arabic. A little warm water brushed on the fish removes the liquid glue. Should any scales show a disposition to curl, a light wash of glue will hold them down. Should the tail-tip or fins dry out and curl by reason of the washing, and consequent soaking out of the glycerine solution, they made be wet with water until relaxed, and painted once or twice with warm glycerine solution, and when dry backed with shellac and tissue paper. When dry, the specimen is varnished thinly, after it has been retouched with dyes and paint.

If a fish be taken while on a fishing trip and the conveniences and materials for casting are not at hand, the specimen may be preserved for mounting by laying it flat on a sheet of paper and tracing around it with a pencil. The skin may then be removed in the usual way, soaked in water and a little salt for an hour or two to remove the blood, drained, dry salted and allowed to dry. Upon arriving at the laboratory, the dry skin may be soaked and relaxed in water, scraped and then treated with the carbon, peroxide, and glue-glycerine solution as with fresh skins. In mounting, a clay model may be made and cast, using the pencil tracing of the dead fish as a guide and fitting the prepared skin to the clay model from time to time to secure the proper proportions; or a thin board may be cut out as indicated by the tracing, tacks driven along the edges all around, and tow or excelsior bound on with thread. The tacks

are then driven in and the excelsior covered and modeled with papier-mâché. When dry, the skin is adjusted as already described.

Clay may be used instead of mâché, if desired, but clay and plaster, unless the absorbing quality, which it has when dry, be stopped by the admixture of dextrine or dilute gum arabic or a similar material, should never be used under a skin. If a generous supply of either dilute gum arabic or dextrine be mixed with the wet clay, it makes a good filling material underneath a skin and works nicely on fish and reptiles.

For exhibition purposes, fish may be mounted hanging or suspended with a string run through the lips, or they may lie flat upon the side. Artificial or imitation aquaria may also be represented by the use of plate glass stippled on the inner surface with white damar varnish; and rocks, sea weed, etc., introduced as accessories. The specimens in the aquarium, either fish or plants, are usually suspended by fastening them to other sheets of clear glass placed at varying distances inside the glass tank and extending in the same plane as the glass front, from top to bottom and the full length of the tank. In this way no suspending nor supporting wires are necessary.

One of the chief difficulties in making imitation aquaria in which mounted fish and preserved or manufactured aquatic plants are shown is to stiffen certain preserved sea weeds so they appear as floating upwards and growing in the water, and not lopped down. To obviate this, very successful aquaria may be made by placing a mirror flat in the bottom of the glass-fronted tank and modeling the top, back and ends in rock or in imitation of the bottom of the pond or ocean. The sea weed and other aquatic plants and the mounted fish, shells, etc., are then fastened to or suspended from the top, the fish being hung upside down. The top and the suspended objects are screened from view by cutting down the exhibition or view opening of the glass front by paneling or otherwise, so that in looking into the aquarium the mirror reflects and reverses all objects and presents them right side up. By this method, imitation aquaria may be constructed very cheaply as compared with the open tank aquaria, and in many instances much better effects and illusions created.

Snakes.—Snakes that are too small to skin are better cast, either in plaster by the use of a paraffine mould, or in wax or cellu-

oid by the use of a gelatin-formalin mould. By the former method, the dead snake is posed as desired on a wet stone, and hot paraffine flowed and painted on until the mould when cool is strong enough to lift off the rock. The snake is then eased out of the mould and liquid plaster poured in. When set, the whole is heated, and as the paraffine softens it is stripped off the cast. When dry, the plaster cast is charged with hot paraffine by immersing it and painted with oil colors. By the use of a gelatin-formaldehyde mould, the snake is posed on a rock or piece of bark, the whole oiled with boiled linseed oil, surrounded with a cardboard casting wall, and the gelatin-formalin composition poured in. When set, the snake is eased out of the mould, and a celluloid or wax cast made in the way already described in the chapter on casting. After casting, the dead snake is dropped into a solution of alcohol and water to keep as a model for coloring the cast, provided a living example cannot be procured to serve as a guide.

Snakes that are large enough to skin are better cast, skinned, and the skin treated in the same way as with fish, and mounted on the cast. As an illustration of this method of mounting, a gopher snake was selected. 'This snake has a very complicated color pattern, besides being richly colored with light yellow, red, brown, and black. To reproduce the pattern and colors on a white plaster cast so as to look anything like the living snake, would mean endless days of toil on the part of a competent artist, and the result would probably be far from satisfactory when completed.

Large snakes are apt to sag and lose their form after death, and if it be possible to secure the snake alive and the preparator be used to handling live snakes, it is better to cast the specimen while it is under the influence of chloroform or ether, but before death has taken place with a consequent relaxation of the muscles. Small snakes may be cast after death. To kill them, place the live snake in a jar with a little chloroform or ether poured on a wad of cotton and the top covered. In a short time the specimen dies and is in fine shape for casting, being limp and not distorted in any way. Snakes killed in alcohol or with the fumes of bisulphide of carbon are apt to die with drawn and stiffened muscles, bisulphide being particularly bad in this respect, tying a snake literally into knots.

In the gopher snake shown in Plate XXIII a piece of cheesecloth containing a small fluff of absorbent cotton was placed over

the head of the live snake and tied firmly around the neck with thread. A little ether was poured into the cotton and the whole at once dipped into cooling paraffine to seal the head tightly and prevent the escape of the ether. A rubber finger stall, for sale at drug stores, may be used instead of the cheesecloth. The snake was then laid on the floor and in a short time the heart action slowed up and the snake lay quietly in any pose in which it was placed, but was still alive.

A slab of plaster cast of a rock was oiled with stearine and coal oil and laid flat on the table, and the snake, oiled and under the influence of the anaesthetic, posed as shown in Fig. 1. Plaster—containing a good proportion of killed plaster and a little liquid glue, so it would set quickly and yet break away easily in the subsequent operation as a waste mould, as described in the chapter on casting—was poured over the snake as in Fig. 2, taking in enough of the rock surface to serve afterwards as a suitable base for the mounted snake. When the snake was completely covered, with the exception of the head, it was allowed to remain an hour or so until death ensued, when the covering was removed from the head, which was carefully posed, and more plaster poured on the head, thus completely casting the entire snake, the body being cast while the snake was still alive. Fig. 3 shows the snake being relieved from the mould.¹ Without waiting for the mould to dry (Fig. 4) it was painted inside with stearine solution. The tail being slender and delicate was made up with a small wire, sharpened at the point and wound with cotton batting like the tail of a small mammal skin, dipped in hot wax and rolled on the table with a flat stick to taper and smooth it. This was placed in the mould, allowing a few inches of wire to run up into the mould. The head was reinforced with a tow-covered wire, when the mould was flowed with plaster, and then thicker plaster modeled on to the depth of half an inch and backed up with a layer of burlap dipped in plaster to strengthen the base. When set, the mould was easily broken away with a small chisel and putty knife and the cast relieved.

¹ In the present instance the author was interrupted in the process of casting and could not wait until the snake died to complete casting the head. The cotton and cloth were taken off the head, the snake soon recovered and wriggled out of the mould unassisted and was placed back in the snake cage. In a few days the snake was chloroformed, placed back in the mould, and the head casting completed.



FIG. 1.—The chloroformed snake posed on the rock.



FIG. 2.—Putting on the plaster.



FIG. 3.—The live snake wriggling out of the mould.

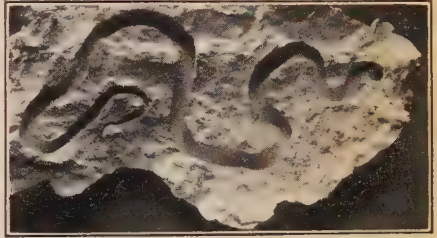


FIG. 4.—The finished mould.



FIG. 5.—The finished cast.

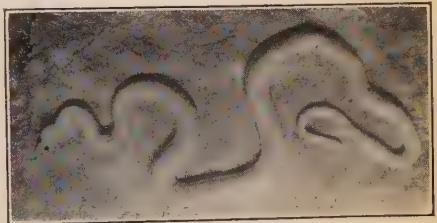


FIG. 6.—The completed snake.

CASTING A SNAKE

With a slender-pointed tool like a long awl, a groove was worked all around the belly of the snake where it touched or joined the rock, for the belly skin to tuck into. Grooves for the lips were made in the head, and the eye sockets scraped out with a small twist drill, and artificial eyes inserted, as in Fig. 5, which shows the cast model ready for the skin. The cast was then placed behind the stove to dry out while the skin was being treated.

Dead snakes may be cast in plaster by the use of the paraffine mould, instead of a plaster waste mould, for this method of mounting, but it is not recommended for live snakes under the influence of chloroform, as the application of the hot paraffine makes the snake twitch and squirm. Just the snake alone, not attached along the belly to any base or pedestal, may, of course, be cast if desired, and the finished snake afterwards adjusted to any desired base; or a wax or glue-composition cast may be made, the skin fitted to it, and afterwards warmed slightly so it will bend and be made to conform to another surface.

The dead snake was cut up the belly from the tip of the tail to within a couple of inches of the head, and the snake skinned, skinning over the head and separating the skin entirely from the skull. The skin was then soaked in cold water containing a little salt to soak out the blood, then squeezed out; rinsed in water and squeezed out; immersed in cold carbon tetrachloride an hour to degrease it; hung half an hour for the carbon to evaporate; and placed in peroxide of hydrogen and water, half and half, a few hours. It was then rinsed in water, squeezed out, and placed in the glue-glycerine solution (Formula 19) where it was allowed to remain overnight, the solution being kept in a warm place. If a snake or fish skin be placed in this solution when the latter is too hot, it will shrivel and ruin the skin, as hot glycerine shrivels soft vegetable or animal tissues. Just sufficient warmth to keep the glue from chilling and becoming rubbery is all that is required, so the skin will take up the glue along with the glycerine. This solution will keep indefinitely, provided a little more glue and glycerine be added from time to time.

Next morning, the skin was rinsed in water, squeezed out, laid flat on the table and thoroughly scraped all over the inside, there being no delicate color lining to a snake as is found in fish. After scraping, the skin was rinsed in water, squeezed out, and wiped

dry with a wad of cheesecloth. Snake skins treated in this way come out transparent and remain so indefinitely provided the skin before death was in good condition. If a snake is about to shed its skin, which it does periodically, the scales are so loosely attached that many fall or brush off during the skinning operations, and the balance will be detached by this or any method of tanning the skin. But if the skin be a new one, the scales will remain on tightly. Furthermore, when a snake is about to shed its outer skin, the under skin thickens and becomes whitish and opaque. Such skins should be avoided for mounting, and only fresh brilliant specimens selected for this purpose.

Water Dyes.—"Diamond Dyes," to be had at drug stores—are mixed with boiling water and strained, and carefully painted on the under side of the skin—yellow upon yellow, red upon red, etc. Whiting and water will answer for white. In an hour or so, the skin is ready to clothe the cast model, the dyes having struck through the transparent skin and showing from the outside.

Le Page's liquid glue, thinned with water and a little plaster stirred in, is painted thinly on the dry shellacked cast and in the slot along the belly. The skin is easily adjusted, in some places a strip being trimmed with shears from the side or cut edge of the skin where it will not tuck far enough into the slot to take its proper position and preserve the color pattern of the body. The lips are tucked into place with a pointed modeling tool, and a few pins driven in about the eyes and lips to hold them in place until the skin sets. After it has dried a few days, the pins are removed and the final coloring and retouching done with water dyes and water color paints. A small artist's brush is used for washes of color and these toned down by wiping with a piece of damp cheesecloth. Pattern markings are intensified with a writing pen and dyes or paints. When dry, the snake is given a light coat of white damar varnish reduced half and half or even more with turpentine.

Snake skins treated in this way and spread out flat on glass and allowed to dry, make very pretty window decorations, and a window may be decorated with dyed snake and lizard skins, and all sorts of colored designs worked out. If the skins are simply to be kept as skins, they may be spread out flat, flesh side down, on a strip of paper and the paper, with the skin attached, made into a roll and kept so for a time. When unrolled, the skin remains flat.

Should the skin be wanted for mounting at a future time, it may be relaxed in warm water, and again placed in the glycerine solution for a few hours and rinsed out, when it will be as soft and flexible as a freshly treated skin. Dry or salted snake skins may be soaked up, scraped, relaxed, and put through the warm solution and come out flexible and transparent with the scales all in place, provided these have not been loosened or lost before the skin is placed in the glycerine bath. This bath sets the scales, epidermis, or hair on reptiles, fish, or mammal skins; and skins of the latter treated in a similar way remain soft and flexible. I have snake skins treated by this method that are five years old, and they are to-day as bright, flexible, and transparent as when first done. A collection of snake skins treated in this way, with the accompanying skulls and measurements as is done with a research collection of small mammals, would in many ways be superior to an alcoholic collection of snakes, much easier to handle, and far less expensive to prepare and keep. Furthermore, specimens preserved in alcohol or formaline deteriorate with age, and the longer they are kept in these solutions the less valuable they become.

Frogs and Lizards.—Frogs and small lizards are better cast, either in wax or celluloid by the use of the gelatine-formalin mould; or by casting in plaster with the paraffine mould. Small rough-skinned lizards may be cast with a hot glue-glycerine mould, without formalin, and by using the glue boiling hot, the epidermis is loosened and pulls off in the cold mould. When the lizard is taken out, celluloid is flowed in, coat after coat, in the usual way, backed up with cotton and celluloid, and finally with hot wax and cotton. The glue mould is trimmed away and then the cast placed in warm—not hot—water and the last traces of the glue mould washed and brushed from the cast, leaving the epidermis mounted on a celluloid cast, with the pattern ready for coloring. Floating of the dead lizard from the rock or base is the thing to be guarded against when the hot glue is poured on. The lizard should be well pinned and glued down with thick shellac, and when possible it is a good plan, in addition, to drill holes through the base upon which the dead lizard is posed and wire or sew the lizard fast to the base. For glue moulds, lizards or snakes should be lightly oiled with boiled linseed oil before the glue composition is poured on. If any moisture from the specimen reaches the glue, the moisture com-

bines with it, softens the composition and sticks and tears away at that point when the reptile is taken out, damaging the mould. After oiling, lizards should be surrounded with a cardboard casting wall and the glue composition poured in. For making wax casts, the composition used in casting wax figures for show windows works nicely. This is made up of equal parts of white beeswax, French wax, and ceresin wax, melted together; ceresin being used instead of paraffine because of its higher melting point, which is 165° to 176° , F., as compared with paraffine, which is 107° to 140° . A little dry plaster, soapstone or talcum are sometimes mixed with the melted wax.

Large lizards may be mounted in the same general way as small mammals, the skins being treated the same as snake skins with the warm glue-glycerine composition. Alligators may be mounted in the same way as mammals, the size of the alligator determining the method that should be used. For the purpose of ornament or as curios, small reptiles may be cast in fusible metal (Formula 18) either from hot plaster or gelatin-formaldehyde moulds. Large objects are too expensive to reproduce in this metal owing to the high cost of the metals. A small lizard posed on a piece of stone and cast in metal, either colored or bronzed, makes a beautiful paper weight; and a variety of such ornaments may be made. For museum exhibits, where the specimen is to be shown under glass, it is hardly necessary to go to this expense, as wax or celluloid casts answer every purpose.

Turtles.—Turtles may be cast if desired, by making a piece of mould in plaster, and from this mould making a plaster, paper, wax, or celluloid cast, according to the size of the turtle; or the head and neck, legs, and tail may be cast separately and set into the natural shell.

Ordinarily, turtles are better mounted. If the under shell, or plastron, is large enough to admit of skinning the animal through the opening, a square piece is sawed out of the plastron, the inside cleaned out and the neck and legs disarticulated from the body as in skinning small mammals, turned inside out, and the flesh removed from the leg bones and feet. In skinning the head, the skinning must stop where the skin grows directly upon the skull and the head left intact, as the skull cannot be skinned out entirely as in small mammals or snakes. If it is absolutely necessary to save the skull

of a large lizard or turtle it may be skinned by the exercise of great care and patience but is not ordinarily done.

If the plastron be too small to allow of a large enough opening to work through in skinning, the shell bridges connecting the under with the upper shell are sawed through and the skin surrounding the plastron cut through about a quarter of an inch from it all around, except the front end which acts as a hinge. The object in leaving the quarter-inch flap of skin attached to and surrounding the plastron is for attachment in sewing the adjoining skin when the specimen has been filled.

When the skinning is completed the whole specimen is well washed in water and submerged in salt brine to cure, and afterwards treated the same as snake skins. In mounting, the legs, neck, and tail are wired and wound as with small mammals, and covered with soft mâché to allow for the proper modeling and wrinkling of the skin. For very large turtles these members are then coupled in the center, using an oblong block of wood with holes drilled through for the reception of the wires, the ends of which pass through the holes and are stapled on the opposite side to hold them firmly. Small turtles may be coupled in the same general way as small mammals. To make all secure, wads of tow saturated with hot paraffine are laid inside around the coupling, and this when cold holds the legs, tail, and head rigid. Dyes, water and oil colors are used on the specimen when dry, as with snakes, and when these have dried the entire specimen may be immersed or painted with hot wax and paraffine thinned with carbon tetrachloride.

Crustaceans.—Lobsters and crabs are best mounted, the hard shell, if properly handled, retaining its original form. In large specimens, each leg and claw is detached from the body, the flesh removed by means of hooked wires, and the inside of the body cleaned out, when the whole is washed in water and then placed for a few hours in salt brine containing a little formalin. After rinsing, the specimen is immersed in hydrogen peroxide (commercial aqueous solution) diluted about one half with water and the addition of a little formalin, where it is allowed to soak a day. Too long an immersion in peroxide will bleach out the colors. After rinsing in water, the legs and claws are injected with warm glue-glycerine solution and then the whole immersed in the solution one or more days according to size. After rinsing in water con-

taining a little sodium arsenite or hide poison, the specimen is placed upon a wire-cloth tray and allowed to dry a few days, the glycerine solution keeping the ligaments at the joints soft and flexible.

A soft wire is then placed inside each leg and claw, and the member bent into its proper position and run full of hot paraffine. Should it be necessary to change the position of the limb after the paraffine has chilled, it may be relaxed by warming and the bend changed. The limbs are then arranged with the projecting wire extending into the cavity of the body. Wads of cotton or tow are dipped into hot paraffine and wax and placed inside the body, thus connecting the wires and making all secure, when the specimen is placed upon its pedestal and allowed to dry.

Small crustaceans may be preserved without disarticulating any of the legs or claws, by drilling a hole in the under side and working a small hooked wire into each member and cleaning out the bulk of the flesh, after the body is cleaned. The inside is then syringed out with the solutions and immersed as usual. When dry, the entire specimen may be immersed in hot wax and paraffine for a few minutes. If a thinner wax coating is desired, the wax may be diluted with carbon tetrachloride. When this is dry, the inside may be injected with wax and paraffine if desired.

By this process the natural colors are retained, and if the specimens be kept away from strong light, the colors will hold indefinitely. This method of preparation of crustaceans is much better than keeping them in formaldehyde or alcohol as is usually done; and in a research collection the specimens may be kept in trays or drawers like birds or small mammals and are easily accessible. Star fish and other marine invertebrates which are amenable to this treatment may also be successfully preserved in the same general way.

CHAPTER VII

SKELETONS

The collecting of skeletons consists in simply "roughing out" the bones by cutting away the meat as clean as possible after the skin and viscera are removed. A hatchet or saw should, of course, never be used in dissecting skeletons. Skeletons are classified either as ligamentary or as disarticulated, generally according to their size. In disarticulated skeletons, the bones are all taken apart, cleaned, and in mounting drilled, wired and bolted together. In small animals the bones are too small to be treated in this way and such specimens are usually treated as articulated, or ligamentary, skeletons, the bones being cleaned but left attached to each other by their ligaments. Snakes, lizards, birds, and mammals up to the size of a fox, are generally treated as ligamentary skeletons for exhibition purposes.

The usual method is to skin the animal, remove the viscera, and with knife and curved scissors cut off as much flesh as possible. The skull is taken off, the brain removed and the interior washed out or syringed with water. If left in, the brain is apt to produce a permanent stain in the skull when dry. The only difficult part of skeletonizing is getting the toe bones out of hoofed animals. In removing these, encircle the bone in the hoof with a sharp pointed knife. Then loosen the bone by working around it with a small screw driver and force it out of the hoof. In large ungulates, like a bison, a hole may be cut in the bottom of the hoof, if necessary, to help in removing the terminal phalanx, or toe bone. The legs or wings are taken off where they join the body, and these members, together with the skull, are packed inside the chest cavity and the whole tied together with string. Large skeletons that are to be disarticulated may be cut into as many pieces as desired for convenience in handling.

After the bones are thoroughly cleaned of all flesh, the sooner they are put into water to soak out the blood, the better. Blood that is allowed to dry in bones, feathers, or fur is difficult to remove and generally results in a permanent stain. In soaking, the skeleton should be suspended or raised from the bottom of the vessel to allow the diluted blood to settle and free itself from the bones. The water in which bones are soaking should be changed once or twice a day, and the length of time required to soak out the blood will depend upon the size of the bones. A small bird or animal will soak out sufficiently overnight, while a buffalo should soak several days. If a stream or other body of water is at hand, a good method is to place the skeleton in a sack and immerse it and tie it fast. Ocean water removes blood nicely. All the larger leg bones should be drilled at both ends to allow the marrow to escape. This is equally true of small specimens.

After soaking, skeletons may be cleaned and mounted at once; or they may be allowed to dry as is usually done on collecting trips. If dried, the skeleton should be dipped or painted with strong arsenic water to keep bugs from destroying the ligaments and eating the soft parts of the bone, and in this condition the skeleton may be kept indefinitely in a dry state, if not greasy. If grease be left in small skeletons, it "burns" or rots the softer bones in exactly the same way as with skins. Skeletons will clean well after immersion in alcohol, but no alum or formaldehyde should be used, as these materially retard the future cleaning processes.

Some writers advocate putting a skeleton in an ant hill, or allowing dermestes to clean it. Such methods are not, however, very practical, as the average osteologist does not keep on hand a supply of trained ants or dermestes that will eat certain ligaments and leave others alone. This might be obviated by painting with poison the parts to be left unattacked, but even then the method is too uncertain and unreliable. If a person were doing small ligamentary skeleton work all the time, dermestes might be put to work cleaning them, but it is a difficult thing to get just the right species of bug to do the work properly. The common black dermeste of the United States is a hyena and eats everything in sight, including soft bone, cartilage and tendon. The smaller peacock-colored bug does nice smooth work, but it is difficult to get enough of them. Then again there is the objection that more or less of the bugs may escape and the work-

room become infested with them so that the importation of foreign dermestes to clean skeletons would be somewhat of a risk. Ants will eat certain parts of a skeleton and will also leave certain parts untouched and the latter dry and blacken. Some animals, such as skunks, most ants will not attack at all.

There is nothing new about the dermeste method of cleaning bones, as any preparator who handles large mammals knows to his sorrow. How often it happens that a set of leg bones designed for future mounting has been hung up in an out-of-the-way place, unpoisoned and forgotten; and at the end of a year or more, when ready to use the bones, they are found nicely cleaned and disarticulated, and many of them lying in a confused heap on the floor. When a preparator has a skull or a skeleton to clean, he wants a practical sure method of cleaning it quickly and well. He can not afford to spend his time hunting for the right kind of a bug to go to work for him. And even if he had them corraled he has no assurance that the bugs engaged do not belong to a trade union and work only during certain hours and perform certain kinds of work.

Skulls and skeletons placed in a fine wire-mesh cage, to keep crabs, etc., from running away with small bones, and lowered into the ocean, if watched carefully come out nicely. Bones of various animals that are cast up on the ocean beach are generally beautifully clean and white, by reason of the constant wetting and bleaching in the sun after the marine animalculae have eaten away the flesh and tendons.

Dry skeletons should be soaked in benzine or carbon tetrachloride and then in fresh water before being cleaned, but the finest results are obtained by treating the fresh skeleton and finishing at once. The usual method of treating disarticulated skeletons is by maceration. This consists in placing the bones in wooden tubs or barrels, covering them with water, and allowing them to remain weeks or months until the animal matter disappears. This method, in addition to the great length of time consumed, is an unpleasant, stinking job, and care must be used in handling not to cut nor prick the fingers on sharp processes of the bones, as blood poisoning frequently results from such injuries even though they be very slight. Furthermore, bones sometimes stain and blacken in maceration owing to impurities in the water. For this

reason, rain water is generally used, and iron nails or other metals are carefully kept out of the tubs or tanks.

Stone crocks are fine receptacles for soaking small skeletons, but wooden tanks are generally used for large bones. During the earlier stages, the water is changed frequently, but as maceration progresses, it is not necessary as the water does not discolor so quickly. When maceration has gone far enough, the bones are soaked in warm soda (carbonate) water, scrubbed with a stiff wire brush and scraped until perfectly cleaned of all membrane, flesh, and tendon. The bones are then soaked in warm water, and treated with Javelle water—water, sal soda, and chloride of lime—to bleach. Degreasing is usually done by placing the bones in benzine and exposing them to the sun's rays. Glass jars, two-thirds full of benzine and covered with a plate of glass, are used for small bones; and a tank also covered with glass is used for larger ones. In large institutions, a degreasing machine is sometimes used. This machine degreases by vaporizing the benzine with steam pipes, the hot vapor entering the bones which lie on wire-screen trays above, and carrying out the grease as the benzine vapor condenses with a cold water tank above. Carbon tetrachloride may be used in the same way, causing very little loss of the solvent.

Ligamentary skeletons are usually placed in water for a few days until the flesh softens, when it is scraped off, leaving the bones attached by their ligaments. The skeleton is then bleached and degreased as with disarticulated skeletons. Aside from the stench and disagreeable work connected with these methods of preparing skeletons there is always an uncertainty as to how the skeleton is going to come out, as to color. Some bones come out beautifully clean and white, while others treated in precisely the same way will turn out yellow or brown, sometimes in spots and sometimes all over. Chloride of lime and soda bleaches bone, but at the same time it eats or corrodes the surface. So the duration and strength of the bleach must be watched carefully or the bones will be spoiled.

In Europe, considerable success has been met with by burying large skeletons, such as whales, in sand and leaving them for a year or longer. This method removes the animal matter and much of the grease. The only thing it has to recommend it is cheapness, and this may be somewhat of a delusion, as to dig a hole large enough to bury a disarticulated whale skeleton, fill it in, and open

it again to remove the bones, is somewhat of a task, and much uncertainty exists as to the final condition of the bones.

All these uncertainties and disagreeable conditions led me to try to perfect a quicker and better method of treating skeletons. While I do not wish to infer that the following methods are incapable of improvement, they are far superior to the old methods in many ways, particularly in speed and cleanliness and, in many cases, in the finished product.

Disarticulated Skeletons.—In so far as the work of cleaning is concerned, disarticulated skeletons are far more easily cleaned than ligamentary bones; as cartilage and tendon are intermediate in density between muscle tissues and bone, and a material that will dissolve flesh will also attack cartilage and ligaments if allowed to act long enough. But the difference in density between bone, and tendon or flesh is so great that the latter may easily be digested away without any injury to the bone. For these reasons ligamentary skeletons require more care in cleaning in order to digest off the muscles without injury to the ligaments. The more carefully and completely they are roughed out, the more evenly the skeleton may be cleaned.

Disarticulated skeletons, after the blood has been removed by soaking, are quickly and easily cleaned of flesh and tendon by simply boiling them in water, one gallon, and potassium carbonate, two heaping tablespoonfuls. For quick work, where a disarticulated skeleton is required for scientific research for comparison with fossil bones, a fresh bird or small mammal may be disarticulated and cleaned by this process in an hour or two, without any scraping. Larger skeletons will require more time, but may be done in the same way. When clean, wash the bones in warm water containing a little ammonia and spread them on a galvanized wire-cloth tray covered with cheesecloth, and expose them to the sun to dry and bleach. If the blood has been well soaked out before boiling, bones treated thus will dry fairly white without any further treatment, and answer every purpose for a skeleton which is to be used only for comparison with other bones.

A tablespoonful of crushed sodium sulphide added to the potassium carbonate with the same quantity of water will dissolve the flesh more rapidly and the potash disintegrates the cartilage and tendon. Sodium sulphide, besides acting as a depilatory agent and

hair destroyer, also digests flesh when in a warm aqueous solution. A strong hot solution of sulphide of soda will dissolve flesh so rapidly that the dissolving flesh will run off like molasses when the hot meat is lifted out of the solution. The stronger and hotter the solution the more rapidly the flesh is dissolved. Sodium sulphide acts more rapidly on the outside of the flesh or muscle than on the inside, dissolving away the surface and leaving the inside in a jellified condition. In order to hasten the cleaning and allow the solution to act evenly so thin delicate parts will not become overdone and fall apart before heavy parts are eaten away, it is a good plan to scratch all lumps with specially designed wire brushes made as follows: Select stiff steel wire of various sizes for different brushes. Cut the wires into lengths about five inches long, and straighten and double them over in the middle into the form of a U. About twenty-four wires make a brush of proper size for handling. Hold the wires together one on top of the other and wind and twist a small wire around the bottom of the U, holding all the double wires bunched firmly together at the base. Make a small wooden handle, about like a lead pencil for small brushes, saw a slot in one end and bore a small hole through the handle just above the slot. Force the bunch of wires into the slot, pass the ends of the stringing wire through the hole, and wind the projecting ends round and round the slot, thus making a wire brush having the form of a paint brush. Snip the ends off even and spread the wires. Stiff brass wire may be used instead of steel wire, thus preventing rust. Individual wires stripped from a piece of galvanized mosquito screening and straightened, make a first-class brush for small skulls and skeletons. For some purposes, as in skull cleaning, a few sewing needles set in a handle in similar fashion are better than wires. The wire brush cuts the jellified meat into ribbons and when put back into the solution, the latter enters and soon dissolves the chunk. Owing to the jellified condition of the meat after it has been attacked by the sulphide solution, it is very difficult to remove with a scraper, and the wire brush is recommended to take its place.

In cooking skeletons, it is a good plan to construct a brass wire-mesh basket to fit the bowl or receptacle in which the cooking is to be done. A number of small-mesh tubes, open at the top, may also be made, each holding one or more skulls. The skeletons or skulls

may then be placed in the wire receptacles and lifted out from time to time to see how the cleaning is progressing, and to examine the bones for lumps that are not being eaten away, or digested, fast enough. As soon as the flesh shows a tendency to jellyfy, scratch the skeleton vigorously along the spinal column, the tail, and the feet, and put it back into the solution again, tying a thread or cord to it to lift it out, if a wire basket is not being used. *All bones should be entirely submerged and not allowed to project above the surface.* This rule holds good for all skeleton soaking, maceration, cooking, or degreasing. It is but a question of time for the flesh to disappear and the bones to cook apart. Sodium sulphide is a good degreasing agent and after cooking bones for a time, globules of oil will appear on the surface of the solution.

As fast as individual bones are done, place them in warm water to soak out the sulphide, which has a tendency to blue the bones. After soaking several hours, spread the bones out to dry. When dry, place them in carbon tetrachloride and allow them to soak a few days to degrease. A better and quicker way, but one which uses more carbon by loss through evaporation, is to place the bones in carbon tetrachloride in a double boiler and heat on the gas stove until the carbon boils, which will be at about 170° F. Boil for fifteen minutes, or longer on thick bones, then set aside to cool off. Carbon tetrachloride, although poisonous, is noninflammable and nonexplosive, and is, in fact, sometimes mixed half and half with benzine to render the latter non-combustible. This mixture is also useful for degreasing bones. Benzine alone will not answer as a degreaser if the bones are to be subsequently bleached in peroxide, as the latter is an aqueous solution and will not act on the greasy surface of a bone after it has been in benzine without treating the benzined bones with carbon tetrachloride to remove the greasy deposit. Carbon tetrachloride leaves no such greasy deposit on the bone surface. After removal from the carbon, place the bones in cold water containing a little ammonia and heat the whole. The released grease will rise to the surface. The bones are then placed in peroxide of hydrogen and water, half and half, to bleach. They may remain in the peroxide solution a few hours or a few days, according to the size and condition of the bones. They are then soaked in cold water an hour or two and placed in the sun to dry and bleach.

Boiling is apt to crack and loosen teeth, and for this reason, the skull may be treated separately by the method described for cleaning ligamentary skeletons. Bones, if properly treated by this method, will come out an ivory white, with a smooth, hard surface; and old greasy skeletons may be whitened nicely by using the carbon and peroxide baths, preceded if necessary by the cooking in carbonate of potash. It is not, of course, necessary actually to boil a skeleton, unless in a hurry. The temperature is better kept at about 175° F., as at this heat the solutions are active enough to clean a skeleton nicely in a few hours.

Ligamentary Skeletons.—As previously stated, ligamentary, or articulated, skeletons will require careful watching in order that the ligaments be not destroyed by overcooking, and young skulls or specimens will require even more care. For ligamentary work, it is recommended that the potassium carbonate be left out entirely and pancreatin (Pancreatin, dry, U.S.P., Parke, Davis & Co., Detroit, Mich.) substituted for it. Potassium carbonate puffs meat, while sodium sulphide jellifies it, and pancreatin has a tendency to harden cartilage and tendons unless it be kept about body temperature. Then it acts as a digester in softening flesh. If heated beyond this, it acts as a hardener of ligaments and is useful in connection with sodium sulphide to clean ligamentary skeletons. For ligamentary skeletons, water, sodium sulphide, and pancreatin, are therefore recommended. These materials will not injure bones, and the stronger the solution in sulphide, the quicker the action.

Too much heat is bad for ligamentary work as it has a tendency to soften the tendons, and a lower and more even temperature accompanied by circulation or motion in the solution is best. For skulls and small skeletons a steam pipe playing into the solution receptacle works best, as indicated in Fig. 3.

This apparatus is very simple and is constructed as follows: Take a gallon oil can with a screw top and solder a crossbar to the screw cap so it is easily detachable. Solder a nipple over a small hole made on the other side of the top, and attach a piece of flexible gas-stove hose or tubing to the nipple. Fill the can three-fourths full of water and set it on a gas plate. When the water boils and the steam comes out of the end of the tubing, lower the gas just so it keeps the water at a boil, and stick the end of the tubing into the receptacle holding the solution and the immersed skeleton. A

glass preserve jar is good for small skeletons or skulls. A string may be tied to them so they may be lifted out from time to time and examined and scratched with the wire brush. With the steam from a gas hose playing in slowly, the solution will get up as high as 208° F. in a quart jar. An open white-enameled bowl about eight inches across, with the same amount of steam playing into it, will keep about 180° F. which is a nice temperature in which to work small skulls and skeletons. Small stone crocks are cheap and excellent for this purpose. Naturally the larger the evaporat-

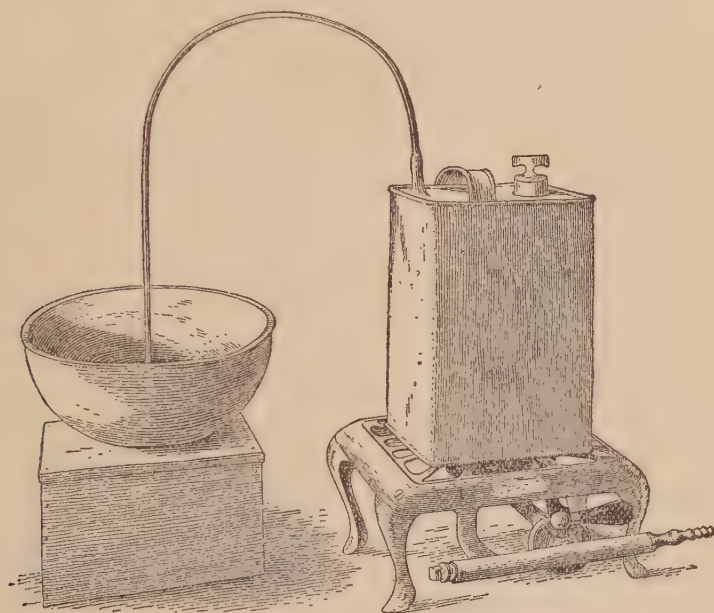


FIG. 3.—APPARATUS FOR CLEANING SKELETONS.

ing surface, the lower the temperature with the same volume of steam. As the steam condenses in the solution the liquid may be dipped out of the vessel and, if necessary, more sulphide added to compensate for the dilution. The steam pipe terminating at the bottom of the vessel keeps the solution in circulation and as a consequence the particles of flesh are worn away more rapidly. Two or more pipes may be attached to the same boiler, and lead into as many vessels and these kept going at the same time. A paddle or propeller working in a vessel also facilitates the cleaning, and a combination of steam pipe and paddle is ideal. In cleaning small

skeletons, the steam from a steam radiator may be utilized for heating the solutions instead of the gas stove and boiler.

From time to time, the skeleton should be lifted out, and the feet, vertebral column, and tail scratched smartly with the small wire brush to facilitate the action of the solution. Small skeletons should have a soft brass wire placed in the neural canal of the vertebral column to keep it in the desired shape, and legs and feet should be tied or lashed to pieces of wire in the pose they are to assume when dry. This lessens the danger of separation when the parts are lifted out for examination, and stops movement at the joints, as movement, like scratching, tends to accelerate the action of the solution and separates the bones. If it is not desired to separate the lower jaw in small skulls, a thread may be tied around them before they are placed in the solution. This stops movement at the hinge joint and prevents the jaw from coming off.

When clean, the skeleton is placed in warm water a short time, and then dried, degreased, and bleached in the same way as already described for treating disarticulated skeletons. When dry, if the bones, or some of them, are not as white as desired, they may again be degreased and bleached. Iron rust spots will sometimes appear. These may be removed by painting the spots with a strong solution of oxalic acid and water, and placing the bone in the sun to bleach. Several paintings are sometimes necessary. But oxalic acid will decompose and corrode the bone surface and should be well washed out with water after the rust spot has disappeared. Rust spots in hair or other materials may be removed in the same way.

For medium-sized or large ligamentary skeletons, sodium sulphide alone, because of its cheapness, may be used if the boiling process be carefully watched, and all heavy or thick spots scratched frequently with the wire brushes. I have seen old and brown, dry, greasy bones treated by these processes, that came out like pieces of bleached ivory. Combinations of these methods, such as the addition of peroxide and carbon to any of the solutions may be made, so that cleaning, degreasing, and bleaching are all done at one and the same time. This, however, is not recommended on a large scale on account of the loss of materials, as the solutions used should, as a rule, be freshly made in each instance, with the excep-

tion of the peroxide and carbon. These may be used over and over again, adding fresh stock as required.

Another method of cleaning dry, greasy skeletons, is to place the skeleton in a jar of benzine or carbon and allow the grease to soak out and loosen for a week or more, according to the size of the bones. Allow the benzine or carbon to dry out, then soak the skeleton in water overnight, following this by boiling or steaming it with sodium sulphide or a combination pancreatin or potash solution. The hot solution releases the loosened grease and dissolves the flesh on the bones, and in many instances the latter will come out clean and white without the peroxide bleach at all. If it is desired to bleach bones that have been treated with benzine in this way, they bleach nicely after coming out of the sulphide boil, as the greasy deposit left by the benzine or gasoline is dissolved off in the subsequent boiling, leaving the bones in proper shape for bleaching.

If peroxide for bleaching is wanted on a field trip, the ingredients in a more concentrated form may be taken to make up the bleaching solution as required, in the following way:

HYDROGEN PEROXIDE

Water	2 quarts
Sulphuric acid (commercial)	1 teaspoonful
Sodium peroxide (dry, in sealed 4-oz. tubes)	$\frac{1}{2}$ teaspoonful
Ammonia	2 fluid ounces

Mixed in the above order.

Pour the sulphuric acid slowly into the water to acidulate it. Without the acid, sodium peroxide in water forms caustic soda, which is not wanted for bleaching. Then add the sodium peroxide, sifting it in very slowly and a little at a time, and stirring meanwhile. When the sodium is all dissolved, add the ammonia, and the solution is ready for bleaching purposes. Too much ammonia or other alkali runs down the solution rapidly and neutralizes it. Too much ammonia added, so the liquid forms large bubbles upon immersed bones, will not bleach at all. The finer the bubbles the better the bleach. A safe method to use in making up the bleaching solution is to test it with litmus paper. The acidulated water should turn blue litmus paper red, and the solution after the addition of the ammonia, should be alkaline enough to turn red litmus paper

blue. Borax may be used instead of ammonia to neutralize the acid if desired. To check maceration and softening of ligaments while bleaching, a little formalin may be added to the peroxide bath.

After coming out of the peroxide bleach and a thorough washing in water, a ligamentary skeleton may be allowed to dry, and then be relaxed at any future time and mounted; or the skeleton may be mounted at once, while relaxed, if desired, and then placed in the sun or strong light to bleach. When dry, detached teeth, jaws, or bones may be united with white absorbent cotton, cut up fine with scissors, and dipped in thick gum arabic and water. It is a good plan to keep this in a small, wide-mouthed, stoppered bottle, pulling off with a pair of fine-pointed forceps the size piece that is required to make the union. A few drops of formalin will keep the gum solution in the bottle from souring or moulding. When dry, the cotton and gum keep their white color and in this respect are far better for joints and small artificial cartilage or tendons, than liquid glue or other yellowish gums.

If a person had enough skeleton work to do to warrant it, a large boiler built on the same principle as Fig. 3 with a larger pipe connected to the top could be arranged. Smaller pipes, with shut-off valves, connected with the main pipe, could be arranged to conduct the steam into the various vessels holding the solutions and bones. With such an apparatus, fitted with a steam gauge and safety valve, by testing with a boiling point thermometer, any desired temperature could be kept up in the vessels by regulating the amount of steam passing into them.

Mounting the Ligamentary Skeleton of a Small Mammal.—When the skeleton has been cleaned, degreased, and bleached, it is ready for mounting. If dried, relax it sufficiently so the ligaments will bend. The body is first taken. A piece of soft galvanized or brass wire is worked down through the neural canal of the vertebral column and the distal end anchored firmly in the sacrum, thus stringing all the vertebrae upon the wire, leaving enough of the wire projecting beyond the first vertebra to allow for attachment of the skull. The backbone with the ribs attached is then bent into shape. A wooden frame, or scaffold, is constructed upon a flat board pedestal and the body suspended from the frame with strings. The legs are adjusted and tied in their proper positions and the attitude of the skeleton worked out. When satisfactory, two pieces of soft

brass wire of proper size to offer a firm support for the skeleton are cut to the proper length for standards, or uprights, to support the skeleton when the scaffold is removed. One end of each wire is placed in the vise and split with the hack saw and the split ends bent into the form of a U to fit the vertebral column, one at the axis and the other in the lumbar region. The proper lengths are determined by fitting them to the suspended skeleton and the uprights cut off and threads cut an inch or so in length, and a brass nut or flange screwed upon them.

Holes are bored in the pedestal and the uprights set in place and held rigidly by screwing nuts underneath. The skeleton is now allowed to rest on the uprights and the tops of the U bent over the tops of the vertebrae. The ribs are spaced by tying a double thread or fine soft brass wire to the neck vertebrae and by twisting the thread or wires taking a turn around each rib, from the first to the last, thus holding them in position, the ends being tied to the back vertebrae. If the tail has been removed, this is wired in the same way as the vertebral column and running the projecting end of the wire into the cavity of the sacrum and inserting a small wad of cotton and gum arabic in the joint. The legs and feet are finally posed, being held in place by lashing soft brass wires lengthwise of the bones, filling the joints with gum arabic and cotton, and pinning the feet in position on the pedestal. When dry, the wires and pins are removed from the legs and feet, and the upper leg bones fastened to the body by drilling small holes through and wiring them fast. The skull is attached by fitting a piece of cork into the occipital opening, drilling a hole through it to receive the wire projecting from the vertebrae, and the other end of the cork fitted into the cavity of the first vertebra, thus holding the skull firmly in place. Broken bones or loose joints are mended with cotton and gum arabic, with a little dry plaster stirred in, if necessary, to match the bone color in some instances.

When thoroughly dry, the skeleton may be transferred to a permanent ebonized pedestal and the uprights and wires painted yellow and, when dry, painted with gold paint; or lamp black and shellac may be used throughout in place of gilding if desired. The same general principles will apply to the mounting of bird skeletons, but one upright being used and that split and clamped upon

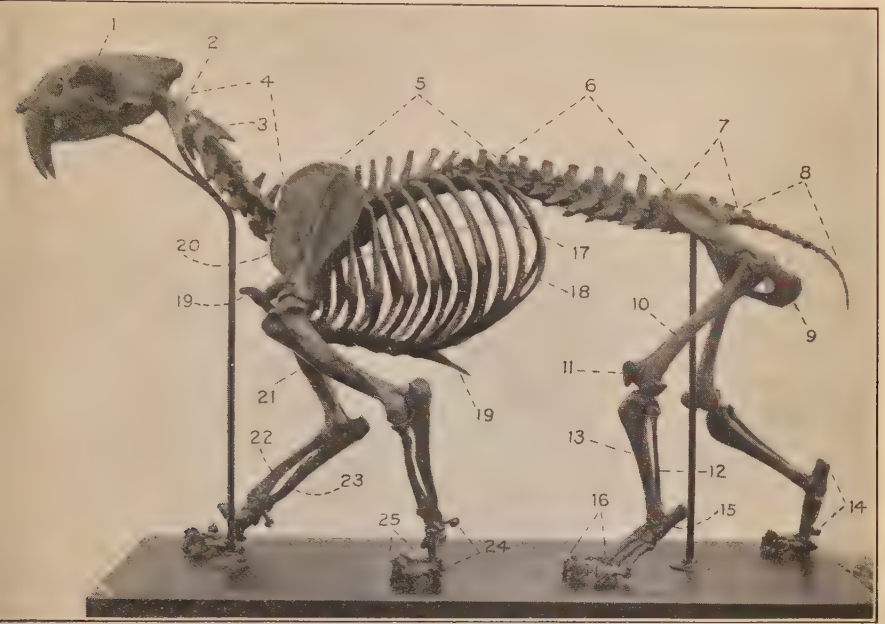
the lower edge of the sternum, or breast bone, with a pin riveted in to hold it firmly.

Mounting Disarticulated Skeletons.—After the bones have been cleaned, degreased, bleached and dried as already described, they must be drilled for the reception of wires to hold the bones in place one upon the other, as the ligaments and tendons have been removed in cleaning. Otherwise the skeleton is posed and mounted in the same general way as ligamentary skeletons.

The vertebral column is first made up. Commencing with the sacrum, the vertebrae are arranged upon the table in their proper order. With a lead pencil, the last lumbar vertebra¹ is marked on its anterior articulating surface, number 1. The next is numbered 2 and so on until all the vertebrae have been numbered. The last lumbar vertebra is now marked on both the anterior and the posterior articulating surfaces with dots, one on either side of the neural canal. The bone is drilled through from front to rear at the points indicated by the dots. Placing this vertebra upon the sacrum, the latter is marked to drill by passing a drill or pointed wire through the holes already made and revolving it, thus indicating the point on the sacrum where the hole is to be drilled. The second lumbar vertebra is now marked and drilled in the same way, and the process continued until all the vertebrae have been drilled. Since in the living animal the vertebrae are separated from each other by a cushion of cartilage, which has been removed by cleaning, this is replaced by artificial cushions made of white felt or soft leather. These are cut to fit the back of each vertebra, tacked in place, and holes for the reception of the stringing wires continued through them.

The next step is to cut a piece of brass wire about three times the length of the spinal column and somewhat smaller than the drilled holes. The wire is doubled and straightened and the ends passed through the sacrum and drawn tight. With this as the starting point, the vertebrae are then strung upon the two wires with the artificial cartilages between them. When the bones are all strung and properly adjusted and the wire pulled tightly so as to make the bones fit snugly to each other, the assembled vertebral

¹ In order to familiarize himself with the names of the bones, I advise the osteological student to procure a copy of Flower's *Osteology. An Introduction to the Osteology of the Mammalia*, by William Henry Flower (Macmillan & Co., London and New York).



1. Skull.
2. Atlas.
3. Axis.
4. Cervical vertebrae, 7.
5. Thoracic or dorsal vertebrae, 13.
6. Lumbar vertebrae, 7.
7. Sacral vertebrae, 3.
8. Caudal vertebrae—varying according to the length of the tail.
9. Pelvis.
10. Femur.
11. Patella or knee pan.
12. Fibula.

13. Tibia.
14. Metatarsals.
15. Calcaneum.
16. Phalanges.
17. Ribs.
18. Sternal ribs.
19. Sternum.
20. Scapula, or shoulder blade.
21. Humerus.
22. Radius.
23. Ulna.
24. Metacarpals.
25. Phalanges.

SKELETON OF EXTINCT SABRE-TOOTHED TIGER, SHOWING THE NAMES OF THE PRINCIPAL BONES

column is laid flat upon a piece of paper and properly posed. A line is drawn upon the paper, tracing the under side of the spinal column in its full length.

A square iron rod a foot or so longer than the spinal column, and one which will pass easily through the neural canal of each bone, is now selected. One end of the rod is flattened into the shape of a spearhead and fitted into the spinal opening of the sacrum, drilled and riveted fast. The rod is now bent to conform to the outline of the spinal column as traced upon the paper, painted with black shellac, and when dry, the vertebrae strung upon the rod, the wires holding them securely in place one upon the other.

A pedestal with an upright frame, or scaffold, is then constructed and the vertebral column suspended with cord as in mounting ligamentary skeletons. The ribs are then held in place, marked, drilled and wired to the vertebrae. The sternum is similarly treated, and the ribs spaced by twisting double wires along the sides as in small skeletons. These wires, in large skeletons, may be afterwards replaced by a flat brass strip, to which each rib is riveted, the strip reaching from the first rib to the last. The pelvis and tail vertebrae are then attached, the tail bones being separated by artificial cartilages as already described. The legs are wired together at the joints, the wires passing through holes drilled as in articulating other bones. The uprights, or standards, for the support of the skeleton are made and adjusted in the same general way as already described. The skull is adjusted on the end of the rod and pins driven through the occipital condyles and passed through both sides of the atlas vertebra upon which they rest. A pin may also pass through the first vertebra and on through the central rod, thus holding it, together with the skull, firmly in place. The joints of the sternum and ribs may be worked over in *mâché*, and all rods, bolt heads, and nuts painted yellow and, when dry, gilded. Gilding done in this way is much more permanent than if the gold paint be placed directly upon the metal.

If special poses are to be represented, the skeleton should be suspended and the bones tied in the exact positions they are to occupy in the finished specimen, and then the marking and drilling done. This of course takes more time, but greater accuracy in pose may be secured than if the bones be drilled and wired before posing.

CHAPTER VIII

ACCESSORIES

PRESERVING NATURAL PLANTS AND FLOWERS

Accessories.—The manufacture of artificial plants and flowers as accessories for exhibition or display groups is an art in itself. One must have an eye for form and color, and deft fingers to manipulate small objects, in order to correctly copy natural vegetation and reproduce it in wax and other materials. It is slow, expensive work, so much so that in many instances the accessory work on a group costs many times more than all the other work on the group put together, including the collecting and mounting of the specimens. In making the foliage for a good-sized tree, where each individual leaf has to be pressed, cut out, colored, and assembled; or, as has been done in some museums, in making artificial cacti for desert groups, where the natural spines were all pulled out, the cactus leaf or branch cast in wax, and the natural spines set back into the wax cast again, one can readily imagine the time and money consumed.

In order to cut down the high cost of making artificial accessories, wherever possible to do so, it is a good plan to pickle and preserve such natural plants as are susceptible to preservation processes and which contain enough woody fiber to hold up after being treated. Soft, pulpy, fleshy leaves and most flowers cannot be successfully preserved by the processes given in the following pages: but moss, seaweed, ferns, most of the grasses, many plants, and such leaves as elm, oak, birch, and beech may be successfully preserved upon the branch or twig upon which they grew. Many things may also be preserved which would be so expensive to make up artificially that the cost would make them prohibitive. In this class are ferns, sagebrush, and the conifers, such as pine, fir, spruce, and hemlock. A group of leopard seals, represented as lying on

seaweed-covered rocks at low tide, as exhibited in the California Academy of Sciences group series, would never have been made if all the seaweed represented in the twenty-five foot group had had to be manufactured artificially. But by preserving the natural seaweed, as was done in this case, the cost was comparatively little.

Many plants preserved by these processes have not the "life" of one well made in wax, but they are at least botanically correct and the true form and character of the plant are preserved; and these may be, and often are, lost entirely by a careless or incompetent accessory worker, especially in assembling artificial leaves in making up a plant or bush.

The chemicals and materials necessary for bleaching, coloring, and preserving natural foliage and flowers are about as follows:

Plenty of clean water.

Table salt.

Denatured alcohol (poison).

Technical acetone (poison).

Sodium bisulphite—dry.

Sulphurous acid—aqueous solution.

Glacial acetic acid.

Oxalic acid (poison).

Stearic acid (commonly, but erroneously, called stearine).

Copper sulphate, crystals (poison).

Verdigris (copper subacetate—poison).

Glycerine (commercial).

Carbon tetrachloride.

Japan wax.

White beeswax.

Raw rubber.

Gum copal.

Liquid celluloid.

White shellac.

Household ammonia.

Glass jars, stone crocks, and wooden tanks.

Water and alcohol dyes.

Turpentine and kerosene oil.

Water and oil colors, artist's brushes, and the tools and materials used in preparing artificial flowers and foliage.

The Wickersheimer solution recommended for preserving plants has the very bad trait of turning most vegetable matter black, after immersion and drying. This is caused by the potash which is called for in the formula and should be omitted. The following formula, varied to suit different plants, is recommended to take the place of the Wickersheimer solution and does very good work, but some vegetable matter after pickling and drying comes out brown. But for simply preserving certain plant specimens that are desired for comparison or where the color is not a consideration, this formula is recommended, being simple and easy to make up.

SOLUTION FOR PRESERVING PLANTS

Denatured alcohol	25 per cent
Acetone (technical)	25 per cent
Glycerine	50 per cent

For some things, the acetone may be replaced in part by glacial acetic acid, both having the same hardening effect upon vegetable matter; but acetic acid, like most other acids, has a tendency to turn the objects brown after pickling and drying.

Immerse the fresh, green vegetable matter at an ordinary temperature—say 70° F.—from four to ten days or even longer, according to the thickness and impenetrability of the fiber of the plant. After removal from the solution, rinse a few minutes in cold water to wash off the solution from the surface, and hang up or lay on wire-screen trays to dry. Grasses and many plants, if treated thus and exposed to strong daylight, as by a window, will in a week or two bleach out to a creamy white. Some come out dull yellow and others quite brown in color. Many plants and some flowers will retain their form and flexibility indefinitely, and may be kept thus simply as specimens, or they may be colored as desired at any future time.

In a general way, it may be said that the longer vegetable matter is allowed to soak in the fresh solution the lighter it becomes in tone, owing to the bleaching qualities of the alcohol and acetone. This solution, made up with either acetone, or a mixture of acetone and acetic acid, will hold the needles on fir, spruce, and hemlock so they will remain plump and flexible.

The density of plant fibers is so variable that it is impossible to give any one formula that will work equally well on all. In pickling

some hard-fibered plants will first have to soak in a weaker solution containing a proportion of water, and a little oxalic acid, and then later be transferred to a stronger one if necessary.

Seaweed should first be soaked in fresh water for a couple of days, changing the water a few times, to remove the slime. The seaweed should then be immersed for several days in the regular formula to bleach and harden. It should then be transferred to another solution composed of glycerine two parts, water one part, and a little thin carpenter's glue, as in the formula recommended for treating snake skins. The fibers of seaweed are of such a nature that they readily absorb glue when in solution.

Keep the solution in glass jars, stone crocks, or wooden tanks, and not in metal cans or tanks. This is especially true if acetic acid be used, as the acid attacks the metal and blackens the solution.

After the solution has been used over and over again, it becomes charged with vegetable matter and discolored. It may be freshened by adding new stock, but after it becomes old and black it loses its bleaching and preservative qualities and should be thrown out and replaced with a fresh supply; or it may be used as a first bath in which to soak out the bulk of the coloring matter from the vegetable material, and then the latter rinsed in water and transferred to a clean solution. By this method the second bath will last a long time.

Some plants in which the leaves will hang on may be allowed to dry, if it is not convenient to preserve them, and they may then be relaxed in water and processed later, being treated otherwise in the same way as fresh material.

Bleaching Foliage.—For the purposes of preservation where color and transparency are a consideration, all vegetable matter naturally falls into two classes—one, such as most of the grasses, those which naturally bleach white or light colored after they have been treated by the preservative bath, dried, and exposed for some days to strong light; and the second class, those which turn brown. The former are much easier to handle as, since they naturally bleach light, they may be simply pickled, dried, and allowed to bleach of their own accord; when they are easily dyed or colored in a high key. Whereas to key up a brown leaf or other object by coloring it, for instance, a very light green, the brown color must first be completely covered with a light-colored opaque pig-

ment to kill the darker color beneath. This kills all transparency, and the finished product is bound to look dead, opaque, and lifeless. Fabrics and other objects may be redyed darker but cannot be satisfactorily dyed a lighter color. Leaves, etc., which turn brown, must therefore be bleached by some process before pickling so that when dry they retain a light tone and do not afterwards turn brown. A quick and cheap method of bleaching certain brown vegetable fibers, such as raw linen for example, has for generations been sought by all the civilized nations on the globe. Other brown vegetable fibers, such as burlap fiber, have never been successfully and cheaply bleached by any known chemical process without so injuring the fibers that they become disintegrated and lose their strength. Even linen bleaching to-day, in many countries, is done by "grassing"—spreading the linen on a lawn of green grass, keeping it wet by sprinkling, and exposing it for weeks or months to the sunlight. Any known chemical bleach so rots the fibers that the finished product is useless. In the bleaching of cotton, wool, silk, etc., for the manufacture of textile fabrics, expert chemists of all nations have for generations been seeking a quick, inexpensive bleach—one that would quickly bleach the fibers pure white without rotting them. Even to-day the process is a long tedious one. Many processes have been invented and patented, and even now different textile manufacturers use different methods. The usual process, which is a long one, is first to boil out the raw materials in a strong alkali, such as lime, caustic soda, or lye, to dissolve the wax which is present in greater or less quantities in all vegetable fibers. After a thorough washing, by one of the processes, the fibers are then bleached in sodium bisulphite liquor. While this bleaches, the material after bleaching will in time turn brown again without an after treatment of hydrogen peroxide, permanganate of potash, chloride of lime, etc.¹

The author carried out an extensive series of experiments in bleaching green foliage, etc., along the lines of the methods used by textile bleachers, but without success. Some leaves would bleach, but by the time they were light-colored enough, the fibers had been so disintegrated and weakened as to render the leaves useless.

¹ For the bleaching of cotton, wool, etc., see *Bleaching and Related Processes* by J. Merritt Matthews, Ph.D. (Chemical Catalog Co., 19 East 24th St., New York City, 1921).

I have not been successful in bleaching foliage of any kind by the use of sulphur dioxide gas. The common method of bleaching by the use of sulphur smoke in a tight container has but little effect on green or pickled vegetation. The still stronger gas made by boiling sulphuric acid and copper over a Bunsen burner and leading the resultant sulphurous acid gas into a tight box containing the green or processed plants, also has but little effect in bleaching anything but the most delicate vegetable fibers.

Without going into further details here, the author concluded that in order properly to bleach such green vegetable matter as would by itself in time turn brown, the first thing to do was to discharge the chlorophyll, or green coloring matter, between the fibers. After this is discharged, the vegetable fibers are more easily bleached and these may then be dyed or colored as desired.

The most successful and least injurious bleaching materials that I have been able to discover for bleaching green or fresh vegetable matter are denatured alcohol, technical acetone, glacial acetic acid, sodium bisulphite, and oxalic acid. Alcohol and acetone are both active dehydrating agents and will discharge the water from immersed leaves or vegetable matter so that shortly after immersion they become "frozen" and extremely brittle, so that care must be used not to handle them roughly or a leaf will snap off like tinder. Denatured alcohol or technical acetone, alone or in combination, discharge the chlorophyll and bleach the fibers at the same time; the bleaching quality of acetone being superior to that of alcohol. If a sufficient volume of liquid be used, many leaves, grasses, etc., will bleach out to a creamy white in one or more days and will not turn brown again when dry, after coming out of this liquid.

In order to hasten the bleaching and to stop the vegetable matter from "freezing" and becoming brittle in the liquid, sodium bisulphite and oxalic acid are dissolved in a little water and added, about as follows:

BLEACHING BATH FOR GREEN FOLIAGE, ETC.

Water	4 fluid ounces
Sodium bisulphite	1 teaspoonful
Oxalic acid (dry)	$\frac{1}{4}$ teaspoonful
Acetic acid	a few drops
Denatured alcohol	1 pint
Acetone (technical)	1 pint

Dissolve the sodium bisulphite and the oxalic acid in the water, then add the acetic acid, and finally the alcohol and the acetone. Sodium bisulphite acts as a bleaching agent, and oxalic acid has both a bleaching and a softening effect upon vegetable fibers. For soft plants, oxalic acid should be left out of the bleach altogether. Hard firm subjects may have more, provided too much be not added or it will soften the stems on many plants, and will strip them from the stalk or twig if used in aqueous solutions. The sodium bisulphite has a tendency to precipitate at the bottom of the solution and this should be stirred occasionally. After a quantity of vegetable matter has been decolorized and bleached, the solution becomes less active and also becomes charged with the coloring matter from the plants, and must be freshened by the addition of fresh materials; or, as recommended for the preservative solution, plants may first go into old solution to discharge the bulk of the coloring matter, and then be placed in a fresh solution. Some leaves in which the brown color is very persistent and difficult to bleach, may be further bleached by immersing them, for one or more days, in an aqueous solution of sodium bisulphite, made by adding about a teaspoonful of dry sodium bisulphite to a quart of water, a tablespoonful of salt, and half a teaspoonful of glacial acetic acid, to liberate the sulphurous acid gas in the bisulphite, as this gas is the active bleaching agent. The foliage is then again placed in the regular alcohol-acetone bleaching solution. After removing it from the bleaching solution, the material is ready to preserve by placing it in the glycerine preservative solution, as with fresh plants.

After remaining in this solution for one or more days at room temperature, which should be about 70° F., the foliage is rinsed in cold water, and hung up, or placed on wire netting trays covered with cheesecloth, to dry. Some leaves will require weighting or clamping between pieces of wire netting or cardboard to hold their shape while drying, as it is sometimes difficult to reshape a leaf that has become distorted in drying. When dry, the foliage, which, in most cases, is a transparent, creamy white, is ready for painting with manufactured dyes or oil colors, either by spraying with the air brush, or by the use of a brush.

Dyeing Foliage, etc.—After a leaf has been properly

bleached, for the most perfect results for a green leaf, it should be first dyed green so that by transmitted light the leaf appears transparent and green, not brown. The object in securing green transparency in preserved or processed green foliage is that the living plant is made that way. In nature, foliage takes up reflected light from different sources, and if a leaf be simply painted on the surface so it becomes opaque, it is an entirely different object.

In order to produce this transparent green as seen in nature, two methods may be used, according to the object to be dyed. Some plants may be sprayed or painted after bleaching and pickling, with water or alcohol dyes. Basic water dyes are good and may be purchased readily from any dyestuff dealer. For many purposes, "Diamond Dyes," for sale at drug stores, work very well when dissolved in a minimum of boiling water and then diluted with acetone. This is a quick way of coloring certain kinds of vegetation, as the light-colored or bleached foliage may be dyed any color, from a light yellow or green to a dark red, either all over, or variegated as in autumn leaves. Some soft things may be dyed sufficiently for a base color after bleaching, by adding green or other colored dye to the preserving formula, but dye in a simple glycerine solution does not color readily. Dyeing after bleaching and before pickling is good for some soft things, but the dyes "bleed" out when the dyed material is placed in the preserving fluid. Dyes which are applied boiling hot by dipping or immersing, do not bleed so readily as cold dyes.

The second method of dyeing, which takes longer, but which produces the finest results upon such subjects as apple leaves, which are green on the front or face side and pubescent or whitish on the back, is accomplished by the deposition of fine particles of a metallic salt, by the osmose principle of dyeing, between the vegetable fibers, as later described. Formerly, much fabric dyeing was done by the deposition process instead of by the later developed principle of dyeing the fibers themselves with coloring matter. Interstitial dyeing, or dyeing by deposition, is now but little used, the artificial dyes manufactured from coal tar and other products having superseded them.²

² See *The Application of Dyestuffs*, by J. Merritt Matthews, Ph.D. (John Wiley and Sons, Inc., London and New York, 1920).

The oldest of the coal-tar synthetic dyes were made from aniline, and this name has persisted as inclusive of all coal-tar or manufactured dyes. At present, many coal-tar dyes are not made either directly or indirectly from aniline, hence the designation of all coal tar, or manufactured dyes, as "aniline dyes," is erroneous. Owing to the fact that these early basic dyes were more or less fugitive, it became a popular impression that all aniline dyes were deficient in fastness and therefore inferior to the old natural dye stuffs. This impression persists in the popular mind to-day, though it is a well-known fact easily demonstrated by actual test, that many coal-tar dyes possess qualities of fastness, or permanency, far surpassing those of the old natural dyes such as fustic, logwood, indigo, etc. This is therefore one of the chief reasons for the decline in the use of the old natural products, and the substitution of the coal-tar dyes, to meet the fastness requirements of both light and washing of present day coloring, as applied to cotton, wool and silk.

While, as above stated, many of the manufactured dyes, contrary to general belief, are exceedingly permanent, or "fast" to light and washing, they are not so well adapted, in mass, to coloring all preserved or prepared foliage as a mineral salt deposited between the fibers, for the reason that manufactured dye, like dipping an object in thick paint, colors everything alike. A natural leaf, for instance, which is green on the front or face side, and whitish and downy, or pubescent, on the back, when dipped in manufactured dye comes out green all over or even greener on the more absorbent back. The manufactured dyes by themselves are therefore of use chiefly in surface coloring on preserved plants by painting or spraying locally; or after the interstitial process of dyeing, which gives the vegetable matter a transparent green color by transmitted light as is found in the living leaf. The ground or base green secured by interstitial dyeing, if properly done, is exceedingly fast to light, some of the colored mineral salts being among the most permanent pigments known. Furthermore, by the process as here described, the green copper salt is deposited only where the natural green occurred in the leaf. Any brown, yellow, or red spots will not be dyed green. These must be touched up afterwards with manufactured dyes or oil paints, should they require it.

Coloring by Interstitial Dyeing, by the Deposition of Copper Salt in the Interstices, or between the Fibers, of Vegetable Matter.—By this method of dyeing, the most natural coloring for exhibition by transmitted light may be produced. The make-up of plants is, however, so varied in density and construction that no one method of dyeing will work equally well on all vegetable matter, which varies from a soft pulp to a dense, woody substance. In the latter, the spaces, or interstices, between the fibers are sometimes so small that there is not room for the deposition of enough coloring matter to produce the desired effect, and such subjects must be avoided for this process of dyeing. For perfect results, a sample of each plant should be tried out by different processes until the best is secured. The chief use of deposition dyeing is to secure a uniform, transparent, green color, and the surface coloring must be afterwards varied by dyeing or painting. Some plants will require no further coloring or “doping,” while others again will have to be touched up to produce the best results, the natural greens in vegetation being so varied.

The grasses and other foliage, which after treatment by the following processes naturally retain their transparent green color and do not turn brown, will be treated first, as the process is a little simpler for the reason that no bleaching is required. *The whole object in bleaching is to stop the preserved vegetable matter from turning brown eventually. Foliage, etc., which will turn brown in due course of time after it has been treated, and which has not been properly bleached, may look fine for a day or a week after it has been colored, preserved, and hung up to dry. But the brown color will gradually creep in and in time will spread over the entire leaf or plant, and the transparent green color disappears, leaving an opaque brown leaf or plant.*

All vegetable matter should be treated while fresh and not in a wilted or half-dried condition. Some foliage may be completely dried, and relaxed by soaking it in warm water, and then colored by this process; but stems are more apt to come out brown than if the fresh material be treated at once. Immerse the foliage in cold water to remove the dirt. Then immerse in the following coloring solution for several days at a normal room temperature —50° to 70° F.:

COLORING SOLUTION FOR INTERSTITIAL DYEING

Water	1 quart
Copper sulphate, dry, ground in a mortar ..	4 tablespoonfuls
Table salt	1 teaspoonful
Alum.....	1 teaspoonful
Denatured alcohol	2 tablespoonfuls
Glacial acetic acid	1 tablespoonful
Verdigris (copper subacetate)	2 tablespoonfuls
Sodium bisulphite	½ teaspoonful

Mix in the above order. Aqueous sulphurous acid may be substituted for the sodium bisulphite and has the same effect. This coloring solution is poison, by reason of the copper salts it contains, and should be kept away from children and domestic animals. Keep covered while in use. A generous supply should be made up and a vessel used which is large enough to afford plenty of room for the vegetable matter without crowding nor crushing it out of shape. Metal receptacles will not answer for copper solutions as the copper is deposited on the metal and all taken up from the solution. Glass jars or earthenware crocks are best for small quantities, and large water-tight wooden tanks painted inside with paraffine or asphalt paint may be used for coloring larger masses of foliage, cat-tails, etc.

For light-colored grasses, etc., the formula may be simplified as follows:

Water	1 quart
Copper sulphate	4 tablespoonfuls
Common salt	½ teaspoonful
Aqueous sulphurous acid	2 tablespoonfuls

By first soaking the vegetation in salt water a day or so, salt may be left out of the solution with the same results, but also with no advantage or saving in time. Interstitial dyeing may be done by the use of sulphates alone, as in the latter formula; or the acetates may be used without the copper sulphate, the verdigris and acetic acid, together with the sulphurous acid or sodium bisulphite, producing a nearly similar result.

These solutions deteriorate and lose their action in about a week and must be thrown out and a new solution made up. A preservative medium for these solutions would be an advantage, but other than adding more ingredients to the old solutions, I have never found anything to keep them from deteriorating, owing to some chemical action which decomposes the solution. Fortunately

he materials are all very cheap. After immersion, vegetable matter first turns yellow or a light brown, then, as the fine particles of copper deposit between the fibers they take on the transparent green color. By lifting a spray or bunch of leaves or grass out of the solution, an examination will determine whether or not it is green enough all over. If not, immerse it for a longer period. Temperature is the determining factor in the speed with which the solution works. If kept about 70° F., ordinary green grass will be sufficiently impregnated, or "done," after a twenty-four or thirty-six hour immersion. Longer soaking will do no harm.

After removing from the coppering solution, rinse in water and then place the grass or other foliage in a basin or tub of water containing about a tablespoonful of household ammonia to a gallon of water, and allow it to soak half an hour or so to neutralize the acids used in the coloring solution. Rinse in clear water, allow it to dry off, and then place it in the regular alcohol-acetone-glycerine preserving solution for one or more days. Then remove from the solution, rinse in cold water, and hang up to dry as usual. Grasses and many plants which do not require bleaching to keep them from turning brown, will, after the above method of treatment, come out a perfectly clear and transparent green, and are ready for surface treatment as afterwards described. Some light-colored grasses and leaves come out too dark a green if coppered too long and then placed in a fresh preservative solution of full strength after coloring. An old solution which has lost most of its bleaching quality may be used; or a preservative solution containing one-third water to two-thirds glycerine, and about four fluid ounces of acetone or acetic acid to a quart of solution, works nicely. This stops the bleaching and the yellow color of the grass combines with the deposited green pigment to produce a more natural grass green color. In some plants which turn brown, this green is exactly what is required, and to make it permanent the foliage must be bleached more or less after coppering, then coppered again, and then placed in the preservative solution or the dyed one-process coloring preserving emulsion, as afterwards described.

It will be noted that throughout the foregoing processes, the only acids used are oxalic, acetic, and sulphurous, the latter being produced by the combined action of acetic, sulphuric, or hydrochloric acid and an aqueous solution of sodium bisulphite. All

acids which I have tried out, with the exception of stearic and oxalic, eventually turn green vegetable matter brown if allowed to dry in. Sulphurous acid is used in many processes of bleaching and may readily be purchased in solution in water. It is, however, easily and more cheaply and conveniently made as required for bleaching foliage, from dry bisulphite of soda, by dissolving the latter in water and adding a little acid to liberate the gas. As before stated, while sulphurous acid will bleach certain vegetable matter and is largely used in bleaching textile fabrics, they will again turn brown unless afterwards neutralized and treated with an oxidizing agent, such as peroxide of hydrogen, permanganate of potash, etc.

The warmer the copper coloring solution, the quicker the action. Fresh foliage that will stand it without pulping, may be impregnated with the copper solution in fifteen minutes or less, if the solution be kept at the boiling point. When first made up, the solution should be allowed to remain at the boil for half an hour, as a certain chemical change must take place before the coloring action will begin.

Place the solution in a glass jar or stone crock, elevate it from the bottom of a water-bath boiler an inch or so from the bottom to keep the jar from cracking with the direct heat from below, fill the outside receptacle with water and set the whole on the stove to cook.

Most foliage, except very soft flexible material, comes out better by the boiling process than when treated cold, for the reason that more or less of the natural wax and gum are liberated in boiling, thus leaving the plant fibers open for the reception of the coloring matter and the preservative solution. Some dense-fibered leaves require a boiling solution as the cold liquor does not penetrate the fibers sufficiently to color them properly. Some foliage which will not color well after soaking several days in cold copper solution, may be rinsed in water and transferred to a hot bath to complete the coloring. After coming out of the hot copper bath, the material should be rinsed in water and then soaked in ammoniated water for an hour, to neutralize the acids, as in the cold coppering process.

Certain grasses, leaves, etc., are so susceptible to the action of the copper solution and take it up so readily that they come out too green if left in too long. This green color may be varied by adding a little yellow water dye to the boiling copper solution.

Either the basic or the acid dyes will answer, but "auramine yellow," a fine light-colored basic dye for cold-process dyeing, will not stand boiling and should therefore not be used in this way. Instead of adding the dye to the hot copper solution, a separate boiling dye bath may be used, and after coming out of the regular hot or cold copper solution, some foliage may be dipped or "topped" with yellow dye to vary the green color produced by the copper solution. The tips of grasses, leaves, etc., may thus be dipped in yellow or red dye, and since the copper solution acts as a "color lake," or mordant, the dye takes readily. Dyes if thus used hot, will not "bleed," or soak out, very much in the subsequent soaking and preserving processes. Cold dyes will soak out more or less and may therefore be used to a greater advantage on the fully processed and dried foliage in finishing. The more a leaf is bleached the less copper it will take up, and as a result the partially bleached and fully processed and dried leaf is lighter in tone. Light-colored apple leaves for example may be bleached a little before or after going into the coloring solution. Soft leaves if left in to bleach to a pure white will not take the copper at all, and these must be dyed and painted.

Stearic Acid Emulsions for Bleaching, Coloring, and Preserving.—Emulsions of stearic acid, besides acting as bleaching agents upon vegetable matter, are also taken up by the plant fibers and thus act as fillers or "plumpers." These emulsions also take dye or copper solutions readily, the stearine acting as a color lake, or base, for the reception of the color. For these reasons, certain vegetable matter may be better preserved by the use of stearic acid emulsions than by the preceding processes.

By reason of its bleaching and plumping qualities, a stearic acid emulsion in combination with the glycerine-alcohol-acetone preservative formula is highly recommended in place of the latter for pickling certain plants and flowers. This is made up as follows:

EMULSIFIED PRESERVATIVE SOLUTION

Denatured alcohol	1 pint
Acetone	1 pint
Stearic acid, shaved with a knife	6 heaping tablespoonfuls
Glycerine (commercial)	1 quart

Heat some water, remove the vessel from the fire, and place in it the vessel containing the alcohol, acetone, and stearine, stirring

the mixture occasionally until the wax is dissolved. Add the glycerine slowly to the half-cooled solution, stirring meanwhile, and finally producing an emulsion when the whole is mixed and cold.

It is difficult to give an exact formula for this emulsion which will produce a mixture that will not separate more or less according to the variation in room temperature, the stearine having a tendency to float upon the surface of the glycerine. The emulsion must be well balanced in order to prevent separation of the ingredients. A good method of preparing the emulsion is to make it up about according to the formula as given. If too thick when cold it may be reduced by the addition of the proper proportions of alcohol, acetone, and glycerine, mixed. If too thin, a thick stock solution, containing an excess of stearine so the cold emulsion solidifies, may be warmed and a portion of it added to the working emulsion. In this way the mixture may be regulated to any degree so as to produce a balanced emulsion. The thicker the emulsion in stearine, the less the separation of ingredients.

Porous vegetable matter, like some of the grasses, violet leaves, etc., will come out too green if placed in the fresh emulsion after coming from the copper bath, and if allowed to remain in the emulsion too long. For this reason the final color of opened-grained vegetable matter is dependent upon the character of the final preservative solution. Some should go into the regular alcohol-acetone-glycerine preserving solution diluted by the addition of more or less water to keep the full-strength alcohol and acetone from bleaching out the fibers and the copper coloring; others may go from this into the regular formula of full strength; others may go directly into the full-strength formula; others again from the regular formula into the stearine emulsion; and still other denser fibered material may go directly into the stearine emulsion of full strength and remain there a week or two with perfect results. As before stated, *no one formula and method of procedure can be given for preserving all foliage perfectly, as the density and composition of plant fibers are so variable that what will work with one will not answer for another.*

An emulsified bleach, which works well, is as follows: Dissolve the shaved stearine in the warm alcohol and acetone and allow it to become half cold. Add dry oxalic acid, sodium bisulphite, and salt. This produces an emulsified bleach similar to the regular

alcohol and acetone bleach, but bleaches further owing to the presence of the stearic acid, which also possesses considerable bleaching quality. Foliage bleached in this emulsion takes the copper coloring readily, provided it be not bleached to a pure white.

The Combination Cold, One-Bath, Copper-Stearine Process.

—A one-bath cold process, combining bleaching, coloring, and charging with stearine at the same time, works better on certain flowers and plants than any of the other processes, as the colors produced are more accurate. This is a combination of the coloring solution and the preserving emulsion, and is made up as follows:

Denatured alcohol	1 pint
Acetone	1 pint
Stearic acid, shaved	6 tablespoonfuls
Oxalic acid	$\frac{1}{2}$ teaspoonful
Salt	1 tablespoonful
Sodium bisulphite	1 teaspoonful
Verdigris	2 tablespoonfuls
Glycerine	1 quart

Warm the alcohol and acetone together. Add the oxalic acid and stearine and stir until they are dissolved. Cool off a little and add the glycerine, stirring until cold so as to make the emulsion. Then stir in the dry salt, sodium bisulphite, and verdigris. The color may be varied, if desired, by the addition of dry yellow or green water dyes to stain the fiber.

The addition of gum camphor and gum copal, previously dissolved in acetone, makes a more perfect emulsion, and one that will not separate so readily as when made without the addition of these gums. These gums also materially stiffen flowers and soft leaves when added to the one-process emulsion. Certain stiff leaves, like orange leaves, which have a tendency to curl, should be taken from the emulsion, rinsed in denatured alcohol and acetone, and soaked a few days in the regular alcohol, acetone, and glycerine preserving formula solution, to which has been added a good proportion of oxalic acid previously dissolved in the acetone and alcohol. This gives softness and flexibility to foliage, according to the quantity of oxalic acid added and the length of time of immersion, and also bleaches at the same time. Oxalic acid in water will strip some foliage, but this does not happen when it is dissolved in denatured alcohol and acetone.

The one-bath coloring emulsion loses its bleaching and coloring

properties by decomposition in the same way as the regular coppering solutions. It is then useful only as a preservative to be used after copper coloring, and may be dyed any color by simply stirring in dry water dyes. All these preservative mixtures containing alcohol, acetone, and glycerine are very highly inflammable and great care should be used to keep them away from fire. They should always be kept covered to prevent evaporation of the alcohol and acetone.

The fresh, green foliage is placed directly in this copper-stearine emulsion and allowed to remain there a week, or two if necessary, stirring occasionally. When perfectly colored all over, the foliage is rinsed in water then in old alcohol-acetone bleach, and may then be placed in either the regular glycerine-alcohol preservative pickle, or in the glycerine emulsion pickle, as usual. Some grasses may be simply rinsed and hung up to dry, and will require no further pickling after coming out of the one-process emulsion.

Some dense-fibered plants may go from the combination one-bath emulsion into a cold or hot copper solution for further coloring before pickling; and many leaves, etc., which will in time turn brown and lose the transparent green coloring if done by the cold or hot copper process only, followed by the preserving bath, will hold up nicely if prepared by the combination cold, one-bath process, followed by the hot or cold copper bath and then a varying length of time in the alcohol-acetone bleach, to further bleach the fibers, and then back into the one-process emulsion again. The reason being that the foliage bleaches out in the combination process, owing to the great length of time it is exposed to the action of the alcohol, acetone, and stearine. In addition to this, both the glycerine and stearine in the solution are charged with copper salt and dye, and this colored mixture is deposited in the woody fiber of the plant, thus making a different and more permanent chemical compound in the fibers. Any deposit of the stearine emulsion which does not rinse off, will later soak off and disappear in the subsequent process of dipping in hot wax and carbon tetrachloride, as later described.

The one-process emulsion may be improved by the addition of cresol varnish instead of gum camphor and copal, one of its disadvantages being the odor arising from cresol (carbolic acid).

This, however, evaporates in time and disappears from the emulsion and from flowers and foliage that have been treated with it.

The synthetic resins produced by the mixture of cresol or phenol and formaldehyde, in the presence of a catalyzer, such as sulphuric or hydrochloric acid, are used in the production of the manufactured articles known as "Bakelite," "Redinol," etc., which have of late years taken the place of hard rubber products for electrical and other uses.³

In the manufacture of these patented articles, cresol or phenol are mixed with a stated proportion of formaldehyde and to this is added a proportion of hydrochloric or sulphuric acid. A violent chemical reaction takes place with the evolution of much heat, so the mixture boils after a short time. When the heat subsides, a synthetic resinous composition results. This is mixed with various fillers, poured into metal moulds, and subjected to a high temperature in an oven for a time; and when cooled and removed from the mould produces articles such as telephone receivers, etc., more cheaply than by the use of hard vulcanized rubber or shellac compositions.

The synthetic resin thus produced is soluble in acetone, and when reduced down to a watery consistency makes an excellent quick-drying varnish and is quite largely used in place of the more expensive shellac. For the purposes of plant preservation, synthetic resin produced by the use of the mineral acids will not answer, as they have a tendency to darken or turn the bleached vegetable matter brown. For that reason, a strong alkali, accompanied by boiling, is used to take the place of the acid, as follows:

CRESOL VARNISH

Cresol (U. S. P.)	50 per cent
Formaldehyde	40 per cent
Sal ammoniac (muriate of ammonia) saturated solution in water	10 per cent

Mix the ingredients and place them in a water bath and boil for two hours, when a sticky resinous mass settles out. Remove from the fire, pour off the aqueous liquor which separates and floats on the surface, and rinse the resin in one or two changes of water.

³ See *Synthetic Resins and Their Plastics*, by Carleton Ellis (The Chemical Catalog Company, 19 East 24th St., New York. 1923).

The resin may be kept indefinitely and will not harden unless baked or subjected to a high temperature for a long time. This resin is soluble in acetone and may be reduced to any required consistency. Used as a varnish on preserved flowers or foliage, it dries quickly and acts as a permanent stiffener, being insoluble in either glycerin or water. Like shellac, it dries with a high gloss. When used quite thick, or viscid, by painting, it makes an excellent stiffener for leaf stems, etc., and may be dyed any color.

In making up the one-process combination coloring-preserving emulsion, add about ten per cent of cresol varnish to the emulsion, the resin being reduced with acetone to about the consistency of ordinary varnish. This makes a more perfect emulsion and does not separate so readily as when the varnish is left out, and also has a tendency to stiffen soft foliage and flowers. The emulsion coloring properties may be varied by stirring in dry water dyes.

"Diamond Wool Dyes" work nicely in this solution and the varnish used in the emulsion sets the colors so that they do not bleed out when foliage is subsequently immersed in the regular preserving solutions. Emulsions of different colors may be made up and foliage may go, in whole or in part, from one emulsion into one of another color. These colored emulsions will last a long time if kept covered, and may be freshened or varied from time to time by the addition of new materials; and, although taking a little longer to make up, the permanency or lasting qualities of the solution and the final results warrant the expenditure of the extra time.

The one-process bleaching-coloring-preserving emulsion with the addition of phenol or cresol is the best all-around formula and the easiest and most economical to manipulate because of its lasting qualities. It will successfully color and preserve a greater variety of plants and a larger quantity of them, than any other medium that I have discovered. It may be used either with or without manufactured, basic dyes.

Dense-Fibered Plants Which Dry Out Brown after Treatment by the Foregoing Coppering Process.—Certain vegetable fibers are so dense and the tendency for them to turn brown is so persistent and apparently irresistible, that they should be avoided if possible, or made up artificially in wax or other materials. If they must be used, they may be bleached as light as possible in the regular bleach, immersed a long time in stearine emulsion, and

then be dyed and painted. The worst that can happen is that the transparent green is wanting, and if the surface coloring be carefully done, that of course remains.

Particularly difficult subjects may be copper-colored successfully by first slightly bleaching, then bleaching further by soaking in the stearine emulsion, and then in the hot copper solution followed by the usual bleach and then in the one-process stearine emulsion preserving bath. They may go back into hot or cold copper again if still not green enough, and the process repeated as often as necessary.

Until the expert chemists who are employed by manufacturers of textile fabrics to "dope out" improvements in bleaching and dyeing discover and make known some new process of bleaching, we will have to be content with simply painting the surfaces of impenetrable, woody, dark-colored leaves, etc., which will not bleach to our satisfaction by present known methods.

Cactus, like prickly pear for example, may be successfully and cheaply preserved by first boiling the cactus in salt and water. This turns the green cactus brown and softens the spines so the cactus may be handled without so much danger of pricking the hands. Holes are then cut in the cactus leaves and the inside scraped out and syringed with water. The cactus is then put through the hot coppering solution, soaked in ammoniated water, and then immersed in alcohol-acetone bleach, followed by the stearine preserving emulsion as usual. After rinsing in water and syringing out the inside to remove the excess of the preserving solution, the cactus is hung up to dry. When dry enough, wires are inserted and hot paraffine is injected with a syringe, filling the interior solid and thus preventing any shrinkage of the outer skin, when the plant is ready for outside coloring if any be needed.

Fruits, etc., having a firm or leathery exterior coating, such as oranges or lemons, may be successfully preserved by cutting a small hole in the side, scooping out the interior, and then treating them the same as leaves. When pickled, and dried for a day or two, they should be flowed inside with hot paraffine or liquid plaster to keep the shell from warping out of shape, as in treating cactus.

Surface Coloring and Finishing.—The quickest way to color pickled foliage is to use tube oil colors mixed with kerosene oil and strained through cheesecloth. These may be used with the air

brush, or spray, for certain things, but for large leaves and grasses the "dauber" is better adapted. This is a small wad of cotton batting tied in a piece of cheesecloth and fastened to the end of a short wooden handle. A little of the dissolved color is poured into a saucer and the dauber slightly wet by painting some on the dauber with a brush or by dipping into the edge of the paint in the dish. The grass or spray of leaves is laid flat upon the table on a piece of board and the color rubbed and ground into the fiber. If too much is applied it may be removed with a wad of clean cheesecloth. Just a little color should be used and this should be well rubbed and worked in.

The alizarin greens and reds are highly recommended by Winsor and Newton for permanency. These being made from manufactured chemical dyestuffs are very transparent and work well. The alizarin water colors are fine for spotting and finishing.

In coloring a branch with the leaves on, which is too large and unwieldy to color on the table, the fingers of the left hand may be placed under the leaves to support them and the color applied with the dauber held in the other hand. The trouble with the air brush spray on work of this kind is that it throws paint where it is not wanted. A cardboard held behind the leaf while spraying will prevent this somewhat. If the underside of the leaf is a lighter color, as is usually the case, this will have to be colored separately.

Sometimes the underside requires dusting with dry plaster or dextrine, pure or mixed with dry colors. This may be applied directly to the freshly painted surface with a soft brush; or what is better, is to paint the dry surface with raw rubber dissolved in carbon tetrachloride, and allow it to dry a few minutes. Where large surfaces are to be thus powdered, or coated with "flock," a powder spray is made as in Fig. 4. An oil can with a screw nozzle has a hole punched in the back or side, a nipple soldered on, and a rubber bulb and hose attached. The powders are then put inside the can through the nozzle opening, and pressure on the bulb throws a puff of powder from the nozzle. For large areas, a steady stream of powder may be produced by attaching the can to a rubber tube connected with a compressed-air tank, and for reaching into difficult places, a rubber tube may also be connected with the nozzle and a piece of cheesecloth tied over the end of the tubing to give an even spray.

After painting and drying but before powdering, some leaves, etc., should be coated with wax as follows: A quantity of beeswax, with or without the addition of stearine or paraffine, is placed in a double boiler and melted, and carbon tetrachloride added until the proper consistency is attained. This is determined by painting a rushful on the surface of a leaf and heating slowly so as to evaporate the carbon. The two will mix as thin as water if desired. Hot wax and carbon should be used as quickly as possible, as carbon evaporates rapidly when boiling, which it does at about 170° F. In a

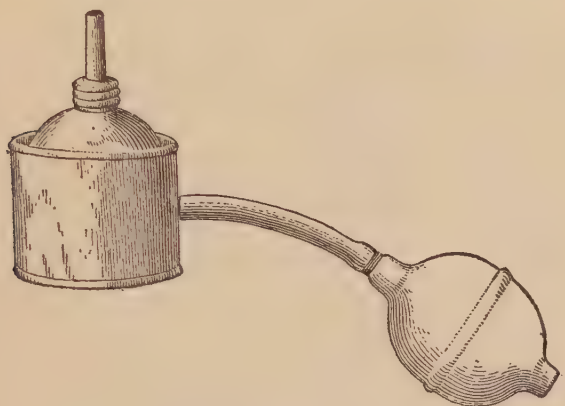


FIG. 4.—POWDER BLOWER.

lay or two the carbon evaporates, leaving the wax in its original hard condition. When the wax is of the proper consistency, if a small object like a bunch of wild oats or grass is to be waxed, the whole, or first one half and then the other may be dipped, or the wax may be painted on with a brush. A quick way of waxing a large complicated surface that would necessitate a large volume of wax if dipping were to be done, such as a branch full of leaves, is by spraying hot wax and carbon all over the leaves, giving the appearance of frost. This should be done out-of-doors or in a current of air, as the carbon gas is unpleasant to breathe, making some people dizzy. The branch is then held over a gas stove or fire, or a portable electric heater of the "Majestic" type is used to liquefy the wax, thus coating all evenly with a thin transparent wax coating. If a slight gloss is desired, shellac or varnish may be mixed with the carbon and wax. Some leaves require polishing.

This is done after the wax is dry by rubbing the surface briskly with a fluff of cheesecloth or a brush such as is used for the hair of infants.

For spraying large surfaces, there are a number of patented spraying machines on the market, but they are generally too complicated and clog easily. To avoid this latter difficulty, the author devised a simple cheap machine, as shown in Fig. 5.

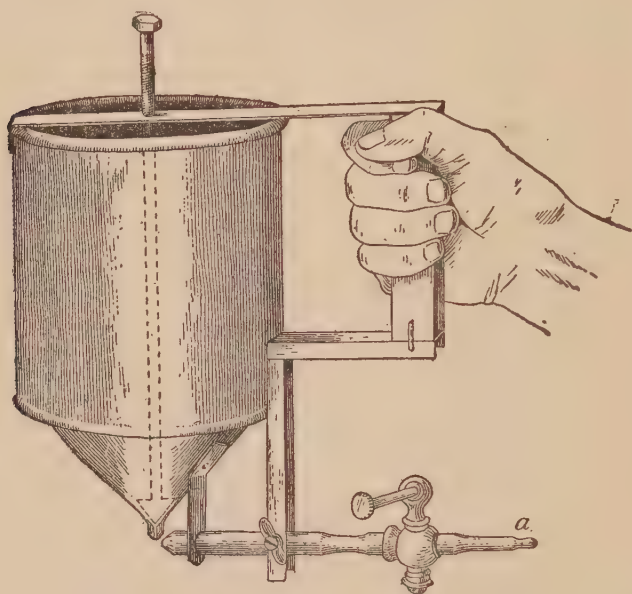


FIG. 5.—MACHINE FOR SPRAYING LIQUIDS WITH COMPRESSED AIR.

A round quart can with a funnel-shaped base is made and a piece of small brass tubing soldered to the apex of the funnel. A small round plug of wood is pushed up inside the tubing and a little hot solder poured in and allowed to cool around it. The plug is withdrawn and the solder reamed out from above and inside the can to fit a plunger on the end of an upright rod, this rod being threaded above to raise and lower by passing through a threaded hole in a quarter-inch cross piece soldered across the top of the can. The plunger thus acts as a needle-valve, opening the hole below when raised and closing it when screwed down. A piece of brass tubing with the front end plugged, drilled, and tapered to concentrate the air, is soldered to the bottom of the can.

so that compressed air going through the tube catches the liquid dropping from the bottom of the can and blows it away in the form of a spray. A gas-cock valve is adjusted to the air tube to regulate the air supply, and a handle soldered on. The liquid supply is regulated by adjusting the needle-valve inside the can. A kitchen boiler laid flat on a wooden base with rubber-tired castors, and a small air compressor and electric motor and belt, all mounted on the same base, with a long electric extension cord, furnishes the compressed air to operate the spray. A long piece of rubber tubing to conduct the air is attached to the hand spray at A, and this apparatus is easily rolled and transported to any part of an exhibition floor or laboratory.

This spraying apparatus is simple and if it becomes clogged, all that is necessary is to open both valves and hold the end of the finger over the air outlet in such a way that the escaping air is forced up into the can, making the contents bubble and boil and thus freeing the congested opening below. This spray is useful for spraying paint or varnish in coloring large rock surfaces. Snow scenes may be quickly made up with this machine, which was designed and made originally by the author for that purpose, in the preparation of a group of winter mule deer in the California Academy of Sciences collection, hot paraffine being sprayed on the fir branches, weeds, and base, and making a most realistic snow scene.

An improvement on this spraying machine has been made by the author, as follows: A coiled spring is placed on the top end of the needle-valve shaft to keep it closed, the valve operating with a lever which opens and closes a valve in the middle of the air tube; so that when the air-valve is opened, as in an ordinary air brush, the needle-valve raises and allows the fluid to drop, whence it is carried away by the compressed air. These spraying devices are very useful, in fact indispensable, for spraying where the air brush or ordinary manufactured spraying machines would soon clog and be useless.

After a branch or bunch of grass has dried, should a second coat of wax be desired, it may go on over the first and be treated exactly the same. This is, in fact, better than having the wax too thick to begin with so as to form drops when cool. Final tinting with oil color may be done over the wax, and before the

paint dries, again heating the wax. This lets the color into the wax and gives a much better effect than if allowed to dry on the surface. In brush painting or spraying fir, pine, or hemlock, instead of making two or three processes of it, the whole may be done at one painting, by using wax, carbon, and dye or oil color mixed together and applied hot. A fine effect may be obtained on autumn and other leaves by daubing three or four colors mixed with wax and carbon, on different parts of the same leaf, and then, by heating, running the colors together.

Another method of producing a surface finish for certain preserved foliage, etc., is as follows: After coloring and drying, dip or paint with raw rubber dissolved in carbon tetrachloride. Cut the rubber into small pieces and put them into the cold carbon. A very little rubber—say a piece $\frac{1}{16}$ of an inch in thickness and in width, and 6 inches long, cut up fine—in a half pint of carbon, makes a solution which is about right for painting. It must be stirred occasionally, and will take a day or two to dissolve, after which it should be strained through cheesecloth. After the foliage is painted or dipped and allowed to dry for a few minutes, apply dry flock or powder of any color. It sticks nicely and gives a fine even finish. Liquid rubber dries flat. A gloss may be given by the addition of varnish. A firmer coating, or one which stiffens leaves, etc., may be gotten by adding a proportion of shaved beeswax. Dissolve the wax in the strained rubber by heating the solution. It may be used warm or cold, depending upon the quantity of wax added. This also dries flat. To give it a slight gloss, heat the painted or dipped foliage over a gas flame after the wax and rubber are dry. This drives it into the leaf and makes it very firm. The leaf may be modeled with the fingers while warm and will hold its shape. If a flat surface is desired over the heated one which may have been given to stiffen the leaf, paint it again with the wax and rubber solution, or rubber alone.

Before waxing grass blades, should they require stiffening, they may be dipped or painted with thin white shellac, and allowed to dry. Or the shellac may be colored, and painted or sprayed on. A transparent effect may be gotten with dyed white shellac that is impossible to produce with oil colors. Gum copal, refined in a mortar, and dissolved in acetone is even better than shellac, and

may be used clear, as a stiffener, or mixed with water dyes. Powdered gum copal dissolved in liquid celluloid, with or without the addition of dyes, is useful for stiffening soft leaves, grasses, etc. This dries with a high gloss, which may be killed by painting with rubber solution if desired.

The best surface finisher and stiffener is celluloid and white wax. Dissolve sheet celluloid in acetone and add a proportion of shaved stearine and white beeswax. Stir until the wax is dissolved, then strain the mixture through cheesecloth. This may be colored with either dyes or oil colors, and should be used cold, by painting with a brush, or it may be thinned down with acetone and sprayed. Several colors should be made up, as follows: a light and a dark yellow, a light and a dark green, one or more reds, and a brown. It is best to make up separate dye solutions rather than mix the dyes together, as by the latter method there is nothing positive about what the color will be when dry. The object in using stearine in the mixture is because it makes a better color lake for dye than wax alone.

Paint the foliage with the light colors first, following with the darker shades and blending the two by stippling. Enough wax and stearine should be used so that it dries flat, unless a slight gloss be desired, in which case a greater proportion of celluloid is used. After the first light-colored coat, dyes alone, dissolved in a minimum of boiling water and then diluted with acetone, may be used over the wax-celluloid coating for greater brilliancy. Soft leaves, like violet leaves for example, may be painted thus a few times and hung up, and be shaped while drying. When dry, they will hold their form and be stiffened, but at the same time flexible. In this respect the wax-celluloid coating is in many cases superior to wax alone.

As many coats as are required to properly stiffen may, of course, be used, allowing each to dry before adding another. The dyed wax-celluloid solution is also very useful in changing or intensifying the color and stiffening foliage that has been colored by interstitial methods of dyeing. There are, of course, many ways in which this coloring process may be changed to suit various requirements. Colors may be softened or distributed at any time when dry by wetting a brush with acetone and stippling the surface of the leaf

with the wet brush and the finger tip. Dyes are easily removed from the fingers by washing in water and "Dutch Cleanser" or almost any of the alkaline soap powders, alkalies acting as a "stripper" or neutralizer of most dyes. Instead of dyeing the wax-celluloid composition, the clear uncolored mixture may be used upon bleached preserved foliage; and this may then be colored with liquid dyes, either by painting or spraying. As before stated, glycerinated foliage does not take dye well, but by coating the preserved material with the wax-celluloid mixture, the coating forms a color lake for dyes applied in the air by painting or spraying, and the dye strikes in. By this means, a large bleached maple leaf may be colored so that there is a gradation in tone from a creamy white on one end, through the yellows, greens, and reds, to the other end, all on the same leaf, the transparency being still maintained throughout.

For greater brilliancy of coloring the method of applying the materials may be changed. A high key and bright coloring may be secured by first painting with dye. Clear wax-celluloid mixture may be painted over this, or colored solution of the same color as the dyed surface may be applied. This may in turn be again painted with more colored solution or sprayed or painted with liquid dye; or instead of using dye for the final finish, oil color paint may be used, clear or mixed with the wax-celluloid composition. By the latter method, if permanent oil colors alone be used, greater fastness to light may be secured, as the dye beneath is protected by the coat of paint from direct exposure to the light and air. Coating the whole when dry with a light coat of warm wax thinned down with carbon tetrachloride also gives the dye a protective coating and softens the colors, besides acting as a further stiffener. Even this coat of wax may be sprayed or painted if desired.

For dyeing processed foliage, basic dyes are best as they may be blended in the same way as paint pigments. "Diamond Dyes," and "Air Brush Dyes," sold at art stores, both work very well with the wax-celluloid solution. Basic and other dyes may be obtained from General Dyestuff Corporation, formerly H. A. Metz & Co., Inc., New York, Chicago, and San Francisco. This is an old reliable firm which manufactures and imports dyestuffs of all descriptions.

A convenient method of applying the wax-celluloid mixture,

Whenever possible, is to lay the leaf or blade of grass flat upon a piece of glass, paint it on both sides, using a wide flat bristle brush, rub it out flat with the fingers and allow it to remain so for an hour.

For some things which are difficult to do by the interstitial process, this method of bleaching and dyeing may be used. It also has another great advantage in that one knows at once what the finished product is to be; whereas by interstitial dyeing methods, sometimes can not be determined for some days or perhaps weeks, just what the exact color is to be and therefore how the object should be surface-colored to be exact and permanent.

A *glacé* finish may be given to soft flat leaves by painting them with the wax-celluloid mixture, laying them face down upon a piece of plate glass previously rubbed with talcum powder, or upon ferro-tin, rubbing them smooth with the fingers, or a roller, and allowing them to dry several hours, in the same way as photographic prints are surfaced.

The wax-celluloid mixture is transparent when dry, and because of this feature, one coat may be applied over the other without greatly lessening the transparency of the object. Fresh white shellac may be used in this mixture instead of celluloid but does not produce quite so good a result and takes much longer to dry. Stems that require stiffening may be shellacked or waxed, and when dry painted with strong hot carpenter's glue. When dry, paint with the wax-celluloid mixture to kill the gloss. In hot weather the glue stiffens while the wax softens, and *vice versa*. The first coat of shellac or wax should not be omitted, or the glycerine in the mixture will combine with the glue and soften it and destroy its stiffening qualities so it becomes worthless as a stiffener.

Leaves, ferns, grasses, etc., which may have a tendency to curl after they have been treated with the wax-celluloid mixture and are thoroughly dry, may be ironed out between cloths with a hot iron; or they may be ironed by rolling them with a warm roller, supporting the leaf with the fingers of the left hand and rolling them with the iron held in the other hand. Soft leaves, etc., in which it is desired to change the form, may be corrected in this way. A convenient roller may be made by sawing off a chunk of $\frac{1}{2}$ -inch round iron rod about $1\frac{1}{2}$ inches in length, drilling a hole in the center of each end for the wire axle, and attaching a wooden

handle. The roller may be conveniently warmed on a piece of sheet iron placed over a gas plate.

Preserving Flowers.—Many flowers may be successfully preserved by the foregoing methods. Tubular flowers and others with broad-based petals are easily treated. The simplest way is to bleach them out first in the regular bleaching solution without the oxalic acid, as the latter has a tendency to soften them too much. Most flowers bleach to a pure white in a few hours. Some flowers which owe their coloring to mineral bases, are more difficult to bleach and require a longer immersion. When bleached sufficiently, the flowers are put into the regular alcohol-acetone-glycerine preservative solution, rinsed, and dried. They are then colored with dyes, water and oil colors, and owing to their absorbent nature take colors readily.

Many soft-petaled flowers may first be bleached, and then pickled in a solution containing less glycerine, say one-third each of glycerine, acetone, and denatured alcohol. The less glycerine there is in a processed leaf or flower, the better it takes dyes. The wax-celluloid mixture works well for coloring flowers. A little gum copal dissolved in acetone and colored by the addition of water dyes is also good for spraying or painting flower petals, as the copal when dry stiffens the petals. Gloss from the gum may be killed by painting with rubber solution, or rubber and wax. Dry colors brushed on over the dry rubber may be used to good advantage for a final surface finish, for both foliage and flowers. These may be used pure, or they may be mixed with dry cornstarch, talcum, dextrine, or arrowroot. The finger tips may also be used to rub on the colors and grind them in, and fine color blendings may be got on preserved or manufactured leaves and flowers by this method, which could not be secured by liquid painting.

Some flowers may be put fresh into the regular preserving solution, or the glycerine preserving emulsion, and left there for a week or more to bleach. They are then rinsed, dried, and colored as usual. If it is desired to color the stalk and leaves by interstitial dyeing, in processing terminal flowers, or those growing only upon the end of a stalk, bleach the whole stalk, with the flower attached. By reason of its soft construction the flower usually bleaches first and the leaves are left in nice condition for deposition coloring. The whole is then immersed in the regular preserving

solution, and rinsed. The stalk is then suspended in the coppering solution, but the flower is not allowed to touch the liquid, as the lower parts are so absorbent that they readily take up the copper, and become discolored. Flowers or leaves which have taken up too much copper may, however, be bleached out again in the bleaching solution, and then transferred to the preserving pickle as usual. When the stalk and leaves are properly colored, again suspend the stalk in the preservative solution. Some flowers may be detached from the leafy stem, processed separately, and fastened back on again.

Processed natural accessories are not only much cheaper and easier to prepare, but groups made with them, if they be carefully done, are far superior in most instances to those made with artificially prepared or manufactured plants. A group such as a goldfinch perched upon a thistle and represented as pulling out the "down" in search of the seed; or a group of 'coons pulling down ears of green corn from the growing stalks, would be almost impossible in the case of the former and prohibitive as to cost in the latter, if they were to be made artificially in wax or celluloid; but both could be done easily and cheaply by the foregoing processes.

Combinations of preserved and manufactured plants may be made, as for example in the daisy or the wild sunflower. The entire flower is preserved, and after waxing and drying, the natural petals are pulled out and replaced by artificial ones. Foxtail and other kinds of grass also work out nicely by pickling, coloring, and waxing the head, running a wire up inside the hollow stalk before or after pickling, and adjusting artificial grass blades. In other words, it is necessary in making accessories to restore only the perishable portions of a plant. Any parts that will dry or preserve so as to be permanent are allowed to remain.

Experimental Studies.—As before stated, each individual plant, for the best results, should be experimented with upon a small scale, in order to determine the best method of processing. Careful notes should be made and a record kept of the methods of treatment in each case. A few examples of the methods employed in bleaching and coloring, and in using the one-process bleaching-coloring-preserving emulsion are as follows:

1. *Foxtail Grass.*—A bunch of fresh green foxtail grass immersed in old, much-used combination dyed emulsion for four days,

rinsed in water, then for a moment in a jar of old alcohol-acetone bleach, and hung up to dry. Result: The grass, including the green heads, while perfectly preserved, was much too dark a green. Another fresh bunch placed in the same solution and allowed to remain only twenty-four hours. Result: Perfect. This grass being soft and porous, absorbed far too much coloring matter by the four days' immersion. Most of the grasses naturally bleach white by themselves if exposed to strong daylight for a time. For that reason, the foxtail grass did not require any bleaching and a twenty-four-hour soaking in the old emulsion was long enough to color and preserve the specimen. When hung up to dry, in a few days it bleached to a light transparent green and the color imparted by the copper salt and dye was permanent. To stiffen and straighten out the grass blades, the bunch, when dry, was laid flat upon a piece of glass and painted with uncolored wax-celluloid mixture. When this was about half dry, the blades were drawn through the clamped thumb and finger, and when dry held their shape and stood up nicely.

2. *Apple Leaves*.—A cluster of green apple leaves, plucked a week or two after the blossoms had disappeared, put into the same old emulsion for ten days, rinsed, and dried. Result: Perfect; the young leaves coming out a fine light color and the older or more mature leaves darker, as in nature. The "down" on the backs came out perfectly, and no "doping" or resurfacing of either front or back was necessary. After hanging about a week, the leaves were slightly lacking in transparency, proving that a little bleaching was necessary. So the bunch was placed into old bleach for six hours, and then transferred to old regular glycerine preserving solution for twenty-four hours. Fresh preserving solution with its full strength bleaching qualities would have bleached the leaves in the same way without the intervening bleaching in the alcohol-acetone bleach. Some of the young tender leaves which required stiffening and shaping were painted with clear uncolored wax-celluloid mixture and shaped with the fingers while drying. The whole was then dipped in a thin solution of warm wax reduced quite thin with carbon tetrachloride. When dry, this acted as a further stiffener to all the leaves. The stems, being quite soft on the younger leaves, were painted with rich hot carpenter's glue to stiffen them, and the bunch hung upside down to dry. To kill the

loss on the stems, they were then painted with raw rubber dissolved in carbon tetrachloride, and white flock dusted over this to restore the stem pubescence.

3. *Live Oak Leaves*.—A spray placed in the same old solution for ten days. Result: A fine transparent green, but the green rather too yellow on the face side. Rather than bleach them out and take the time necessary to recolor them by process work, the faces were painted with green dye and green wax-celluloid mixture over this. When dry, the whole was dipped into warm wax and carbon solution to give it a wax coating and to lock up the glycerine. When dry, the front surfaces of the leaves were brushed smartly with a fluff of dry cheesecloth to give them the required gloss.

4. *Magnolia Leaf*.—A large leaf placed in old one-process solution for two weeks. Result: It colored perfectly and looked beautiful for a few days. It then began to grow dull and lifeless and in two weeks turned brown. A fresh solution of the same formula (bleaching-coloring-preserving emulsion), made up with the addition of "Diamond" light yellow and light green wool dyes, added glycerine to the solution, and well stirred. A second fresh leaf immersed for two weeks. Result: Very good, but owing to the density of the fibers, it is difficult to get enough coloring matter into the leaf to produce a perfect result. The leaf was much improved by painting the face with green wax-celluloid mixture and when dry painting this again with green dye, keeping away from the light-colored midrib in coloring. To reproduce the gloss, the face of the leaf was painted with dilute white shellac. A third leaf was placed in fresh solution for two weeks, rinsed and then immersed in alcohol-acetone bleach freshened by the addition of new materials, for forty-eight hours to bleach. It was then placed back in the coloring solution for a week. Result: Perfect; and no "doping," or recoloring, required.

5. *Orange Blossoms*.—A spray of fresh orange blossoms with the leaves on was rinsed in cold water to remove the dirt, allowed to dry, and immersed in fresh one-process emulsion containing verdigris, without any dye, for one week. Rinsed in water, placed in clean, fresh bleaching fluid for an hour, and then soaked three days in the regular glycerine preservative solution with the addition of oxalic acid and sodium bisulphite to further bleach the blossoms

and to keep the solution clear. Rinsed in clean water, then in clear bleaching fluid and hung up to dry. Result: The leaves and stem colored nicely, but the blossoms absorbed a trifle of the verdigris—just enough to throw them off a pure white. The blossom and buds were painted with clear wax-celluloid mixture with the addition of plenty of flake white, oil color. This gave the proper color and the tips of the stamens were touched with thick wax-celluloid plus light yellow dye. Some of the smaller leaves and the blossom stems were a trifle light in color. These were painted with light green wax-celluloid mixture, the whole dipped in warm wax and carbon, and when dry the faces of the leaves polished with a piece of soft rag.

6. *Maple Leaf*.—To produce a richly colored autumn leaf, the following methods were used. A fresh green maple leaf was immersed for two days in old bleaching fluid. It was transferred to fresh bleaching fluid without any water, and after two days' soaking came out a beautiful cream white. It was then placed in glycerine preserving solution for two days, rinsed and hung up to dry. It was then painted with yellow, green, and red wax-celluloid mixture, on the face side only. The result was very satisfactory but lacking in brilliancy.

A second leaf was bleached in the same way and then immersed in stearine preservative emulsion two days. Rinsed in water, then in old bleaching fluid. The leaf took up more or less of the stearine and made in the leaf a better color lake for the reception of dyes. Freshly made dyes, dissolved in acetone, were sprayed with the air brush on the face of the leaf. This was painted over with dyed wax-celluloid mixture, and this again sprayed with dye yellow over yellow, green over green, red over red, and blending the two wherever they joined. Spotting was done with brown-colored wax-celluloid solution and Winsor and Newton's par water colors. The stem was painted twice with red wax-celluloid mixture. The junction of the stem and the back of the leaf was painted with shellac and, when dry, painted with hot glue. When dry, this was painted with rubber solution and white cornstarch dusted on to kill the gloss. The whole, when dry, was dipped in very thin warm wax and carbon. The second leaf was by far the best and most brilliant in color; and spraying on the dyes gave

much smoother coloring and blending than painting on the solution with a brush only, as was done with the first leaf.

The Permanency of Preserved Foliage.—So far as the permanency or lasting quality, of natural foliage preserved by the foregoing formulae is concerned, glycerinated vegetable matter, if properly prepared, is good for an indefinite number of years. Grasses, etc., colored with copper salts and then glycerinated, and hung up inside of a window where they have been exposed to strong daylight for the past three years, are just as good to-day as when first preserved, both in color, form and transparency.

In the preparation of the group of moose in the American Museum of Natural History, New York, about 1894, all the moss, ground pine, etc., used in the group were preserved with a glycerine solution. Being interested in knowing the present condition of these preserved accessories and whether or not they still retained their plumpness, flexibility and strength without deterioration, after a lapse of thirty years; and also whether evaporation from the glycerine or other materials had left any deposit on the inside of the glass case, I recently sent a letter to my old friend Mr. James L. Clark, Chief of the Department of Preparation in the American Museum, and had the following response:

Mr. John Rowley,
Los Angeles, Calif.

DEAR MR. ROWLEY:

Under separate cover, I am sending you a box of moss, etc., taken from the moose group, which to me looks "as good as new." I inspected the glass, which has not been cleaned inside for three years and it is remarkably free from any "fog." In fact, only by the closest inspection can you detect it and I am surprised that it is not more in that time; not from the moss, etc., but from the ordinary film that deposits on any glass. I believe that the effect on the glass from glycerinated accessories is practically zero.

The rest of the group is in fine shape and looks as though it had only been mounted and completed yesterday.

With best wishes, I am,

Very sincerely yours,

JAMES L. CLARK.

Although I have not done any experimenting along such lines, it is quite probable that some of the processes described here, especially in the treatment of flowers and pulpy vegetable matter, may be shortened and improved upon by the use of a vacuum, in the same general way as fruits are preserved and made into jams, by

extracting the air and juices in a vacuum and then injecting warm sugar solution. In treating soft vegetable matter, a wax solution, or one of the synthetic resins, could doubtless thus be injected.

The preservation of natural flowers and foliage is an art that has been much neglected, and it is my hope that others may take up the subject and bring it to a higher degree of perfection; nothing being further from my thoughts than to claim that the foregoing processes are incapable of improvement.

MAKING ARTIFICIAL PLANTS AND FLOWERS IN WAX

Modeling Foliage.—In modeling artificial foliage, as in other branches of taxidermy, nature is the guide. If a certain plant or flower is to be modeled, make careful studies of it beforehand, and, if possible, work right up to the very last from the natural, living plant. If a living plant cannot be secured, pickled, or as a last resort, dried, or pressed specimens will help in the final assembling. Photographs and drawings are also useful. The purpose for which the finished product is to be used will, of course, determine the quality of the workmanship. A bush or plant that is to go into a large group and be viewed only from a distance does not require the fine touches demanded of a flower that is to be seen at close range in a small group. At a distance, the general effect is all that is necessary, and if this be bad, attention to fine details will not help any.

Tools and Materials.—The tools required to model artificial plants and flowers are chiefly keen eyes, deft fingers, small, fine-pointed scissors, and a "modeling pin." Other than these, those given in the list following are essential. In procuring modeling pins, which are used as hat-pins by women, select only the very stoutest and stiffest that can be found. In default of these, take a black glass bird-eye or black-headed hat-pin, heat the glass head over a gas flame, slowly at first so it won't crack, until red hot and transfer the head to a piece of stiff steel wire. Round umbrella wire is good. Revolve it in the flame till the ball is symmetrical and globular. Then allow it to cool. Sharpen the other end of the wire and a good stiff modeling pin results. Modeling pins with different sized heads are desirable, ranging from an eighth to a quarter of an inch in diameter.

A pair of heavy scissors for cutting thin wire.

Small cutting pliers.

Soft iron and steel wire, Nos. 18 to 40.

Silk or cotton covered wire, to be procured of dealers in milliners' and artificial flower makers' supplies.

Bleached beeswax, Japan wax, paraffine and stearine.

Rosin and boiled linseed oil.

Absorbent cotton.

A few yards of silk crêpe or mousseline.

Dennison's crêpe paper—white, light, medium and dark greens, yellows and reds.

Casting plaster—dental plaster preferred.

Arrowroot; white and yellow dextrine, dry.

An assortment of Winsor & Newton's tube oil colors.

Turpentine, formalin, kerosene oil and white shellac.

Water and oil dyes.

Dry powder colors.

Le Page's liquid glue, carbon tetrachloride.

A couple of agate-ware double boilers; and a few flat, round, agate-ware or white-enameled pans that will take the place of the upper vessel in the double boilers, to hold a smaller quantity of wax.

An assortment of sheet wax of different colors.

For pressing leaves, a press as shown in Fig. 7 and in Plate XXVIII will be necessary. In making the accessories in the groups for the California Academy of Sciences, the author developed and used a foot press. This was later discarded in favor of the lemon-squeezer hand press as shown in the illustrations, the latter doing faster and better work and being far easier to manipulate. A Thayer and Chandler (Chicago, Ill.) air brush, with tank and foot pump, complete, for small work; and for large work, a bigger tank and an air compressor and electric motor are used to operate the air brush and sprays.

Coloring Wax.—A double boiler, the lower vessel being filled with water, should always be used in heating wax, as if it becomes too hot, certain colors when mixed with wax deteriorate very rapidly. Even with the double boiler, colors deteriorate, so that a shallow pan fitting into the top of the boiler base and holding only a workable quantity of wax is best for leaf pressing. A large potful may be colored and allowed to cool, and a portion of it

broken off and added to that in the pan as required. This saves keeping the whole mass hot and spoiling the color.

Canada balsam gum is ordinarily used to soften and temper wax. This, however, is expensive and ordinary rosin mixed and softened with boiled linseed oil is cheap and has the same effect on the wax. The rosin is placed in a pressed—not soldered—double boiler and the bottom vessel filled with sand instead of water, as greater heat may be gotten in this way. When heated sufficiently, the rosin melts, when boiled linseed oil is stirred in until a thick varnish results. Enough oil should be put into the rosin so that when cool it remains about like thick molasses, and a spoonful may be dipped out, thus saving the time of heating the mass to soften it every time it is needed, the whole being kept as stock. About two large tablespoonfuls to a pound of melted wax tempers the wax about right for leaf and flower work. If too much be added, the wax sticks to the fingers and tools.

Ordinarily in coloring wax, a tablespoonful of hot wax is dipped out, a little oil color squeezed into it from a tube, and the wax and paint ground together intimately with a flat stick. The spoonful of colored wax is then put into the hot wax and stirred, the colored wax going off in waves and tinting the mass. This process is repeated until the whole body of wax is of the proper color. This method is good but takes considerable time. An easier and quicker method is to dissolve oil color in a minimum of carbon tetrachloride, strain it and keep it thus in open-mouthed stoppered bottles, as stock. This should be well shaken before using. A little of the dilute color is poured directly into the hot wax and stirred, the color mixing readily and evenly with the wax. A few drops of the mixture are allowed to cool on a piece of white paper to test out the color, or a scrap of white paper may be dipped into the wax to try it out. In compounding a green, a very little diluted Prussian blue may first be added, then light chrome or cadmium yellow, and this may be varied with a little orange or sienna to take away the rank green tinge. By this means wax may be quickly and easily colored or tinted, the small amount of carbon that was used soon evaporating.

Brighter tints may be had with manufactured dyes in many instances, and these should be used instead of oil colors when great transparency is desired. Oil dyes dissolved in carbon work

nically with wax, but oil dyes are limited in variety, and if the proper color cannot be procured, water dyes may be made to mix with the hot wax by first dissolving the dye in a minimum of boiling water and then adding alcohol and a little acetone and straining the liquid through double cheesecloth. Should any specks of undissolved color or dirt appear in the melted wax, strain it through double cheesecloth, wipe out the vessel and pour it back again. Hot wax with rosin is very inflammable and care should be used that the water in the lower vessel be not allowed to boil away. For the finest work, pure bleached beeswax should be used. Paraffine or ceresin may be mixed with wax for making cast objects as it gives better transparency than wax alone, but the addition of paraffine makes wax "short" so it cracks in modeling. To cheapen the cost of materials, for coarse work when a very light color is not essential, unbleached beeswax may be used. White Japan vegetable wax may also be used in some processes and this works well mixed half and half with white beeswax.

In most of the processes of making artificial grass, leaves, and flowers, the late Mrs. E. S. Mogridge used "crêpe lièse" or "mouseline," each being a fine gauze-like cloth. This was dipped in hot tempered wax and formed the basic material for all work, the cloth furnishing the fiber and thus strengthening the wax. While the cloth reinforced the wax and kept it from falling apart in case it were broken at any time when cold or old, it did not materially stiffen the wax or keep it from wilting if the wax became too warm.

In order to overcome these obstacles, the author discarded cloth almost entirely, except in assembling foliage, and substituted Denison's crêpe paper. This paper is crinkled in the manufacture in such a way that it will stretch out when pulled across the grain. The paper is made in white, light, medium and dark green, and a variety of other colors, being dyed with water dyes. If the proper color cannot be found, white paper may be colored or dyed to suit. Mix tube color with kerosene oil, then dip or paint the crêpe paper and wipe off with cheesecloth and hang up to dry; or the color may be sprayed on, one side one color and the reverse side another. The purpose for which the paper is intended should first be decided. If for leaves from detailed moulds or moulds with deep modeling, all the stretch that is in the paper is demanded. If

for smooth moulds, the paper, which is cut into strips of the required width across, not lengthwise of the crinkle, is pulled out, thus stretching out most of the crinkle. If the paper is to be colored by spraying, it is best stretched first. For many purposes, any soft grade of tissue, or even heavier paper, will answer.

Make the paper into a roll, and holding the end, dip the roll into hot colored wax and draw it out again. The more slowly the paper is drawn out, the thinner the coating of wax. The back of a hack saw blade held against one side of the paper as it is being drawn out scrapes off the hot wax on one side and reduces the thickness of the deposit. Waxed paper may be further reduced in thickness by placing it between blotters and ironing it with a hot flatiron. The heat from the iron melts the wax and the paper absorbs it. The waxed sheet should be taken out at once while the wax is warm. In making artificial wax grass blades, if they are to be made long, it is an advantage to reduce the weight at the tip by ironing in this way. Waxed paper or cloth may also be made heavier at the base by first drawing it out of the hot wax slowly, and then finishing by pulling up the lower half quickly, thus depositing a heavier coating on the lower end.

Where greater stiffness is desired, and where wax foliage is designed to withstand heat and possible wilting, cut the paper into strips across the grain as usual and dip them in white shellac and pin them up to dry. The shellac may be colored with oil colors or dyed with water dye if desired. When about half dry and so it may be handled nicely without sticking to the fingers, dip the shellacked paper into the hot wax as before. Paper made in this way is very flexible and easy to work, and in a few days the shellac hardens and stiffens the wax sheet. These sheets should, of course, be used while fresh. Most leaves and grasses are best pressed and made up in apple green crêpe paper, all ready prepared by the manufacturers, and run through white shellac, and then through hot colored wax. Hot carpenter's glue may be used in the same way for special purposes, the paper being pinned up and allowed to become dry, and then placed for a few hours in a dampening box, and when relaxed, dipping in hot wax as usual. The water dyes used in preparing the colored papers are, however, partly stripped by dipping in hot glue, but are not much affected or "stripped" by the shellac bath.



FIG. 1.—The blades cut out with the scalpel



FIG. 2.—Grooving the blade.

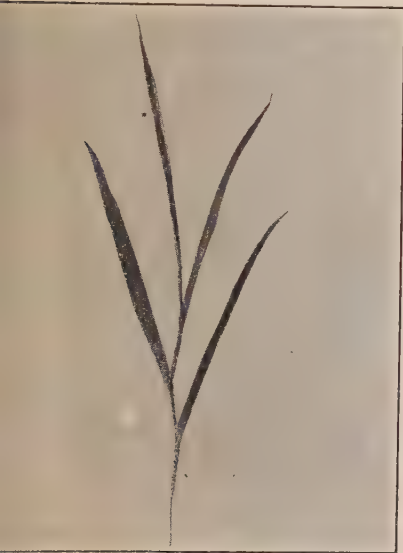


FIG. 3.—The blades assembled.



FIG. 4.—Double wax blades reinforced with wires.

Modeling Grasses.—For making artificial grass, a light green paper, cut lengthwise of the grain and not crosswise, is selected, stretched, and cut into strips of varying width, about the length of the blades of grass to be made. White paper may be used and sprayed a dark green at the tip and a lighter tone in the center, leaving the base white. When the paint is dry the paper may be dipped in white shellac, dried, and waxed, or the shellac coating may be left out for short grasses and the paper dipped directly into light green-colored wax.

The waxed paper is then laid on a piece of glass slightly dampened by rubbing it with a wet sponge or cloth, and with a sharp scalpel the blades are cut out as shown in Plate XXV, Fig. 1. Another method is to cut out the blades with long scissors. The blades are then grooved down the center by holding them lengthwise of the forefinger of the left hand and with a flat awl pressing lengthwise, as shown in Plate XXV, Fig. 2. If the scissors or awl stick to the wax, draw them through the moistened lips. The blades are then folded partly together and modeled into any desired form. Better grass blades may be made by coloring the paper and cutting out each blade with shears, and then dipping each blade separately into hot green wax, base first, and drawing it out quickly. This leaves a better edge and takes away the cut appearance usually seen in modeled grass, but takes more time. Thin sheet celluloid, either plain or colored, cut into proper shape and dipped separately into colored wax, also makes good grass blades.

To mount the blades, select about number 20 annealed iron wire, several feet long. Place one end in a vise or attach it to a nail driven into the bench, and pull stoutly on the other end. The wire stretches and when relaxed, remains straight. Rub it smartly with a piece of wax, before or after straightening, and cut it into lengths, these varying with the height of the grass to be made. Warm the base of a blade over a gas or alcohol flame, and wrap it around the top of the wire, wrapping or covering the wire an inch, more or less, by twirling between the thumb and finger. The wire is then bent at an angle at the base of the wrap, and a second blade is adjusted by twirling an inch or more of the base of the waxed paper around the wire as before. The light base of the blade thus becomes the stalk of the grass, which is usually lighter in color than the blade tip. Any final spraying, spotting, or blotching may

now be given, either with water or oil colors. Grass of any reasonable height may thus be made, as in Plate XXV, Fig. 3.

Another type of grass, without the central groove and with long blades, may be made by cutting out the blades as before, laying one flat down on a sheet of moistened glass, placing a fine waxed wire lengthwise in the center of the blade, and pressing it in place with the fingers, allowing the wire to project a couple of inches beyond the base. A second blade is laid on and pressed with the fingers, the edges being even and parallel, and with the modeling pin head, the two blades are united or welded by rubbing them smartly lengthwise. The whole is then lifted off the glass, and, owing to the wire reinforcement, may be bent or curled at will, as shown in Plate XXV, Fig. 4. Very small leaves may be made in this way, without the use of moulds as later described, being modeled into shape with the modeling pin.

Before curling or modeling the blade, to represent the fine longitudinal grooves present in some grass, lay the blades flat on the dampened glass and scratch them lengthwise with a package of fine sewing needles set evenly in a slot in a wooden handle, the needle points tracing upon the wax fine parallel lines. The blades are mounted on wire as in the preceding method of making grass, but the wire projecting from the base of the blades is bent down and wrapped or bound fast to the central supporting wire with a piece of thinly waxed paper or crêpe, of a lighter color than the blade. This is rolled or twirled between the thumb and finger and rubbed up and down with the ball of the thumb, until perfectly smooth, the distance between blades being made as in the natural model. Preserved and partly dead blades may also be used toward the base as these work in nicely with the artificial ones. In this way a stalk of grass a couple of feet high may be constructed and the blades upon it made to vary in length and width. Should one wire not be heavy enough to support the stalk without bending, when wrapped part way down, additional wires may be added and bound fast to the main wire with waxed cloth or paper.

Rushes are made in practically the same way, but in order to secure greater thickness in the middle, several pieces of waxed paper are used and welded together, the first and last being the widest so as to leave a thin edge. Oats, wheat, "timothy," or red top may be represented by preserving the natural stalk in the preservative



FIG. 1.—Plaster mould of leaf.

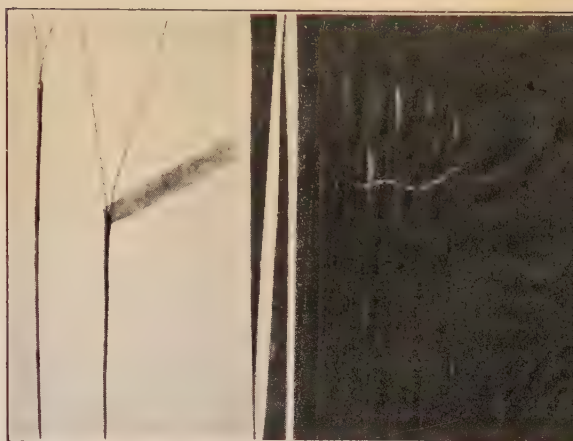


FIG. 2.—Winding stems.



FIG. 3.—The pressed leaf.



FIG. 4.—The regular and the irregular notch.

lution, running a thin wire up inside, painting and dipping the stalk in hot wax and adjusting artificial blades.

Long cat-tail blades or tules are well represented by selecting dried cat-tails that have died naturally and dried up and bleached. If cut green, unless they be pickled, they shrink badly in drying. In either case paint them with oil color and kerosene, using a cheesecloth dauber, and hang them up to dry. When dry, dip them in hot green wax.

The waxing is done by taking a long piece of iron pipe a couple of inches in diameter and soldering a metal cap on one end to make it watertight. This is set into a bucket of water on the gas stove and a second jacket, made of a long piece of tin leader pipe, is put over the first, or inner tube, reaching all the way to the top. Hot colored wax is poured into the inner pipe or tube, the steam coming up inside the outer jacket and keeping the tube of wax hot. In this way cat-tails and tules may be waxed in a very short time and are stiffer and smoother than if painted with wax thinned down with carbon. Natural cat-tail heads may be easily preserved by drying and then immersing them in hot paraffine. When charged, plunge them into boiling carbon tetrachloride and "swish" them around so as to dissolve off the excess of paraffine from the surface. When dry they may be colored if necessary.

Leaves.—In order properly to represent green leaves of any great size, it is necessary to make moulds of the natural leaves, those which show the strongest character or venation being chosen for casting. By the Mogridge method, a plaster mould was made of only the front or face of the leaf as in Plate XXVI, Fig. 1. When dry, the mould was boiled a few minutes in borax water or paraffine and allowed to dry or cool. The surface was then wet with the tongue and a sheet of wax was pressed with the thumbs to every line of the mould. A wax-wound wire midrib, or "stem," made as in Fig. 2, was laid on, and a piece of waxed crêpe cloth laid on over this and pressed and kneaded with the thumbs and the two layers thus welded together as in Plate XXVI, Fig. 3. The wax leaf was then removed from the mould, cut out with scissors, and the notching of the edges imitated with scissors, as shown in Plate XXVII.

While this method is simple and requires but few tools and answers for making leaves for many purposes, the backs of wax

leaves made in this way are generally unsatisfactory and crude. Waxed crêpe paper is better than gauze cloth for backing as it makes a stiffer, stronger leaf, and is more easily notched than cloth. If warmed a little while pressing, waxed crêpe paper may also be used for the face impression, instead of a sheet of clear wax.

In order to get better results and make a wax leaf that is more perfect on both sides, it is necessary to make a mould of both the front and the back of the leaf, adjust the moulds in a press, and stamp the leaf out of hot waxed paper or other material. This is much more satisfactory and is performed in the following way.

Making Plaster Leaf Moulds.—By the Mogridge method the natural leaf, after soaking in cold water a short time, was held by the stem and liquid plaster poured on the face with a spoon and the excess allowed to run off at the tip, back into the plaster bowl. The leaf was then laid down carefully on newspaper, and after half a dozen leaves had been thus coated, more plaster was poured on a few of them until a sufficient thickness had been built up to provide strength for pressing, the larger the leaf the thicker the mould. When hard enough to hold together, the plaster with the leaf in position on the under side was lifted off the paper, turned over, and the edge all around trimmed away with a scalpel, just clearing the edge of the leaf. Any plaster that had run under so as to bury the edge of the leaf was worked off, while soft, with scalpel, and artist's brush, and water, and the leaf cleared of plaster all over. The plaster be allowed to harden on the under side and bury a leaf. It is difficult to remove it without damaging the mould. Hence the desirability of casting only a few leaves at a time so the mould may all be cleared before the overlapping edges harden. In half an hour or thereabouts, the leaf was stripped off the plaster, the mould trimmed all around the edges, and set aside to dry out, after which it was boiled in hot paraffine wax, cooled, and was ready for pressing, as in Plate XXVI, Fig. 1.¹

The making of double leaf moulds is more complicated and takes considerably longer than casting just the face of the leaf as already described. In making some of the foliage for the large groups in the California Academy of Sciences, the author made copper electroplated leaf moulds, backed up with type metal. Which

¹ For a detailed description of this method of making wax foliage, see *The Art of Taxidermy*, by John Rowley (D. Appleton & Co., N. Y., 1898).

PLATE XXVII.



FIG. 1.—Snipping the edge.



FIG. 2.—Breaking off the ends.



FIG. 3.—Thinning the edge.

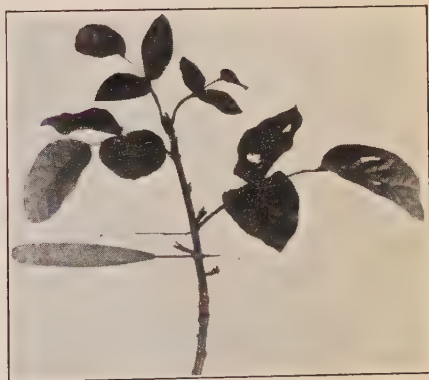


FIG. 4.—Assembling.

NOTCHING AND ASSEMBLING LEAVES

These moulds made fine leaves, they were expensive to make and more permanent than necessary, and unless one be in the millinery or an allied trade where the moulds are needed for turning out thousands of leaves, the making of electroplated moulds is entirely warranted. Portland cement or magnesite may be used to make harder moulds, but for ordinary purposes good casting plaster answers every purpose, as, if carefully handled in the press, but few moulds will be cracked if they be made thick enough. The addition of tow or hemp fiber to the plaster strengthens it, but it is not necessary except in very large moulds.

To make double leaf moulds so they will fit the press uniformly, a set of tin forms, or casting boxes, of different sizes is first made as follows. Blocks of soft pine wood 3 inches thick are sawed out in a miter-box, each block a little longer and wider than the preceding one. Strips of sheet tin are then cut, one set of strips being about $1\frac{1}{2}$ inches, and the other set 3 inches wide, with perfectly parallel sides and smooth edges, and long enough to reach around the block and lap over at the end. Bend them snugly around each block, using a vise and mallet, so the finished form open at the top and bottom is like the text, Fig. 6.

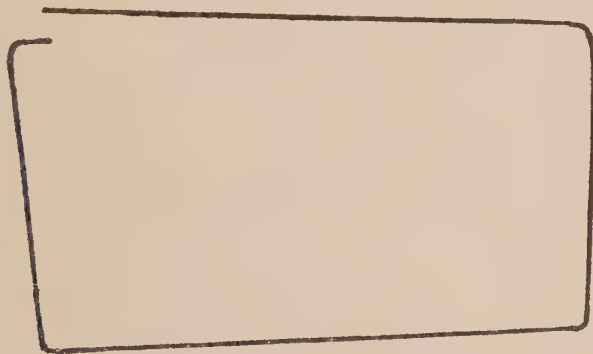


FIG. 6.—TOP VIEW OF CASTING TIN FOR MAKING LEAF MOULDS.

In this way two sets of tin forms are made from each block, one being $1\frac{1}{2}$ inches high and the other double, or 3 inches, allowing the tip of one end to overlap or hook over the end of the long side to keep the tin closed. The longest should be about 7 inches and the smallest 1 x 3, and for convenience in storing the tin should nest snugly inside of the next largest in the series.

If lumber is scarce, the largest block may be made and the tins bent around it, and then the block sliced down in the miter-box to make the others. But it is a convenience to have more than one set of tins for certain sizes of leaves, and it is therefore best to make a complete set of blocks and keep them for future use.

In selecting natural leaves for casting, only perfect specimens should be taken, and these should be the very strongest in character and detail and without undercuts. Fresh leaves are best, but if it be impossible to procure them, pickled leaves soaked in water to plump and freshen, will answer in most instances. Fresh foliage may be placed in a tight box containing a wad of wet cotton and sent by mail or otherwise, and kept fresh for casting for several days.

The selected leaves are put in a basin of water to cleanse and plump. A leaf is lifted out of the water by the stem and the water shaken off. Warm—not hot—paraffine is painted on the back to stiffen it and make it retain its true form, and the leaf dropped into the water again. All the leaves are thus paraffined. A smooth flat board is laid on the table and well greased with stearine and lard heated together, enough lard being added so that when cool, the mixture will paint smoothly with a brush. The more lard, the softer the composition. A leaf is laid on the board, paraffined side down, and soft potter's modeling clay adjusted all around the leaf, between the leaf and the board, to keep plaster from running under. If the leaves be small, several may be cast and pressed in one mould, in which case the leaves are arranged on the board in a row, side by side with the stems all pointing one way. These are arranged to come inside of a long narrow tin. The tin is then painted with grease and set in position over the leaves. Some downy leaves require that one or both surfaces be oiled so the plaster will draw, but in smooth leaves oiling is not necessary.

Plaster is now mixed and the leaves painted with it, and blown with the breath to kill bubbles and drive it in, and then the plaster is poured into the tin, filling it to overflowing. While cleaning out the mixing bowl and tablespoon, the plaster will have hardened sufficiently so it may be struck off smoothly along the top edges of the casting tin. When set enough so the plaster will not run, the whole is slid along the board and off the end so as to stop the suction of the plaster, and the mould turned upside down. The clay is re-

oved with a scraper, and with an artist's brush and water the raffined side of the leaf is freed and cleaned of all clay or plaster that may have run underneath, and the mould is set aside to harden.

When firmly set, the tin is removed, the top surface all around the leaf smoothed up and made as flat as possible, and keyed close the edges of the leaf by drilling three or four shallow holes with large twist drill. The mould is brushed off and held over the flame to warm the paraffine slightly, when the flake of paraffine readily lifts off. The edges of the leaf are now examined for imperfections and these are worked off with scalpel and scraper. The leaf itself is brushed lightly with a dampened brush to cleanse it, when the upper surface of the mould surrounding the leaf is painted with the grease. The broad, greased, casting tin of the same diameter is adjusted to the mould and a rubber band slipped around to hold it tightly in place against the sides of the mould. Plaster is now mixed and painted on the face of the leaf and the tin filled as before, and when partly set, struck off to square it. When set, the tin is removed and the mould set aside for an hour or more to harden, when it is pulled or wedged apart, the leaf lifted out with forceps, and the mould set aside to dry out.

In pressing, it is an advantage to have every mould as small as possible, and not to leave any unnecessarily wide flange or surface surrounding the leaf. So long as the entire leaf is represented, that is all that is necessary. In cutting down moulds so as to have them as small as possible, saw and reduce one half of the mould first, then set the other half in position on top of it and saw around the first as a guide, using throughout a small hand saw and an improvised miter-box made by nailing a long block on top of a piece of board and making a saw cut in the block through the middle, for a slot in which to work the saw.

When perfectly dry, the moulds are well brushed off, immersed in boiled linseed oil for an hour, drained on a piece of wire netting arranged over the oil vessel, wiped dry with a wad of cheesecloth and set away to dry and harden. Moulds may be used at once after running out of the oil, or dry plaster moulds may be simply painted a couple of times with boiled oil and used in the press at once. Moulds that are to be used for pressing at once should not be soaked long enough to become saturated with oil, as this makes the plaster soft, like cheese, and they wear and break easily on the

press. The longer oiled moulds are kept, the harder they become, like old putty.

For pressing leaves in a double or squeeze mould, a press is, of course, necessary, and the one shown in Fig. 7, and in Plate XXVIII, works admirably. To hold the bottom half of the mould in position, the points of two wood screws, about two and one-half inches apart, project upwards from the bottom of the press to the height of half an inch and fit into two holes bored in the bottom of the mould for their reception. A sheet iron pattern or templet is made with two holes bored through it, the holes being so placed

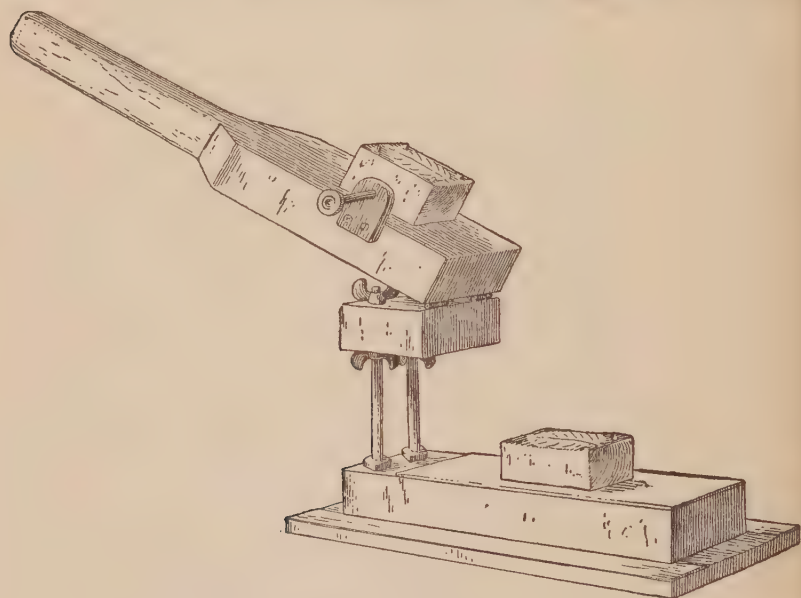


FIG. 7.—HAND PRESS FOR MAKING WAX LEAVES.

that the templet fits snugly over the two projecting screws. The templet is used on all moulds to fit them for the press, the flat templet being placed in position on the underside of the bottom mould and with a twist drill, bore holes into the mould deep enough to receive the screw points in the press. When the mould is set in position on the screws, it cannot shift lengthwise or sideways, but is lifted off the screws each time in pressing leaves. The top half of the mould is held firmly in position upon the upper lever of the press by means of two long, pointed, $\frac{1}{4}$ -inch machine screws or bolts passing through threaded stationary nuts on either

of the press, the points of the screws digging into the sides of the mould, as shown in the figure and plates.

The upper lever of the press is made adjustable for moulds of varying thickness by hinging it to a block of wood which works up and down on two $\frac{1}{2}$ -inch upright bolts fastened to the bottom of the press. With a wing-nut above and one below on each bolt, near the ends of the block, the distance of the hinging point of the lever in the bottom of the press may be regulated. To adjust a mould in the press, the lower half-mould is simply set in position on the new points. The upper half is placed on top of the lower and the lever brought down and allowed to rest on the mould. Be careful to see that it strikes the upper surface of the upper mould evenly, when this is exactly in place on the lower half. If it does not, it is made to seat accurately by adjusting the wing-nuts at the end. The screw-clamps at the sides are then screwed into the upper mould, holding this securely to the upper lever, so that when raised the two half-moulds separate, and when thrown down the moulds come exactly in place and seat accurately upon each other.

Pressing Leaves.—Before starting to press leaves, a plentiful supply of midribs, or “stems,” for the support and attachment of the leaf is necessary. Wire of different sizes is used for stems, but rather than use a heavy wire, or one heavy enough to support a moderate or large-sized leaf, it is better to use two or more light wires bound together by twirling and wrapping with a small fluff of absorbent cotton, one of the wires projecting beyond the others and thus giving a fine tapering point, in the same general way as in making stems by the Mogridge method. After the leaf is pressed and finished, the wires projecting from the base are bound with more cotton if necessary and dipped into hot wax and twirled and smoothed with the thumb and finger to complete the stem. In order to save time, in some leaves the stem may be made first by dipping long cotton-covered wire into a metal tube of cooling wax, cooled for the light stem color. This coats the wire thinly, when it is laid aside to cool and another one dipped and laid aside. The first one is again dipped—quickly so as not to melt the coating already on the wire—and another coating deposited upon the first. In this way wire may be coated smoothly and evenly to any desired diameter. The coated wire is then cut into short lengths suitable for stems, a little of the wax stripped off the tip of the wire, and

the wire wound with a small fluff of dry absorbent cotton, which serves for the tip of the stem and is dipped into hot wax when pressing. By this method, when a leaf is pressed the stem is also made.

By the squeeze-mould process, hot wax is used instead of cold or a combination of both. It is an advantage to cut a hole in the center of the pressing table, box it in below the table, line it with tin, and set in the gas stove at a lower level than the table top as shown in Plate XXVIII. When the double boiler, having a shallow pan for the top, or wax receptacle, is set in place on the grating or flat iron bars over the gas stove, the hot wax thus comes more nearly on a level with the mould as it rests in position in the press. The press is placed flat on the table and screwed fast, as close to the wax kettle as possible and at the same time far enough away to escape the rising heat from the gas stove below, as the hotter the wax the better the pressed leaf. Obviously, the greater the distance the mould is from the wax, the more time there will be lost in transferring the hot wax from the pan to the mould. Time in the transfer is therefore the greatest factor in leaf pressing and the quicker the leaf be stamped out of the hot wax the finer the impression. The temperature of the accessory room should be kept at about 70° F. or even warmer than that if possible. The temperature of the moulds also has a good deal to do with the definition produced in pressed leaves. It is a good plan to arrange a sheet of tin to act as an apron, fitting half way around the wax vessel and sloping down to the press as shown in the plate, to catch the drip of hot wax in pressing and keep it away from the fire below. Hot wax is very inflammable and care should be used in handling it over a fire and in seeing that the water does not boil away in the absence of the preparator, thus making the wax take fire.

Everything being in readiness and a mould adjusted to the press, which lies before us open, or with the lever thrown back; the tin with which the entire base and inside of the press is lined, and the sides and faces of the mould, are painted liberally with olive or salad oil, using a medium-sized paint brush with the oil. For the first impression, plenty of oil should be used to keep the hot wax from sticking, and as the first cast or impression from a leaf mould is generally a sample test to see that the moulds are

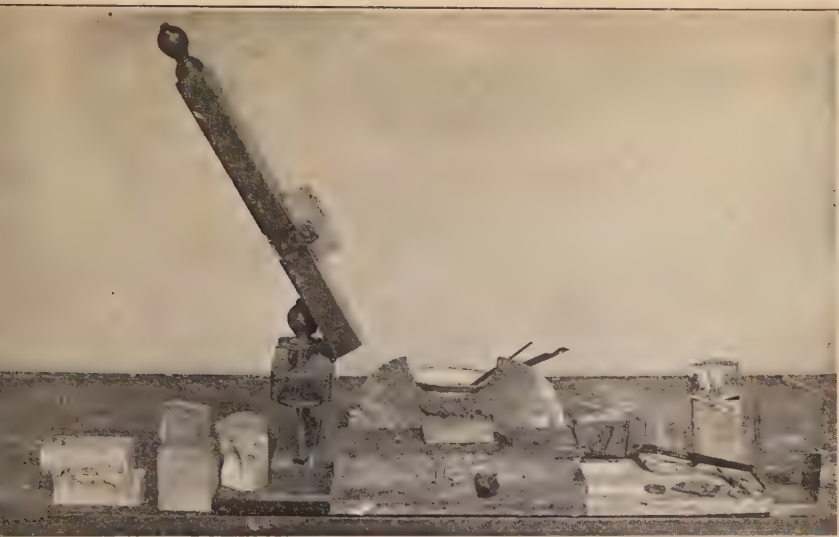


FIG. 1.—Arrangement of the press and materials.

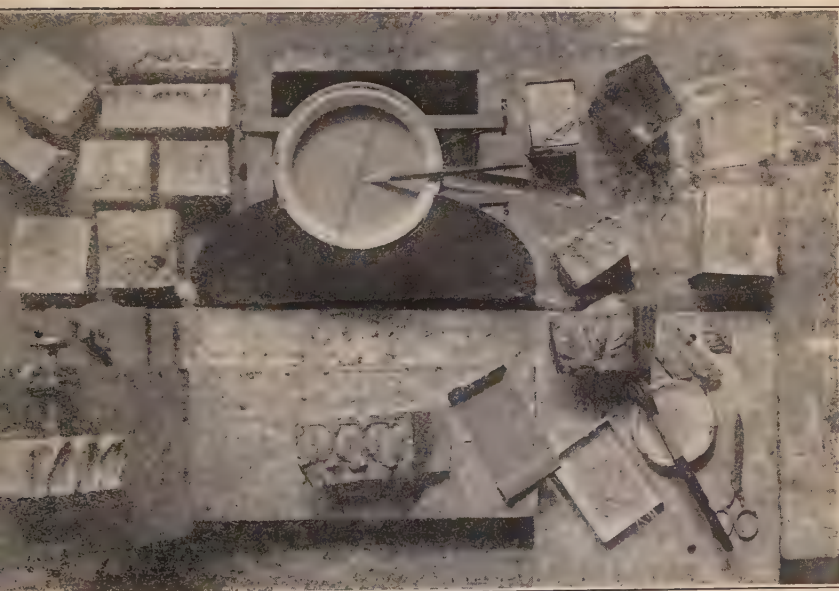


FIG. 2.—Top view of Figure 1.

PRESSING LEAVES BY THE HOT WAX METHOD

properly adjusted and will therefore produce an even, sharply defined leaf, an excess of oil does no harm.

With a small flat brush, paint a little hot wax along the stem-groove area in the lower mould, dip the cotton-covered stem wire in the hot wax and lay it in position on the wax which was painted in the mould, pressing it lightly to make it stick. The stem should reach about one-third the way up the mould to insure a good firm support and attachment for the leaf. The object in painting the hot wax in the groove area is to make sure that the stem will stick and hold, otherwise if the stem be laid directly in the oiled groove, the oil saturates the cotton and keeps the stem from binding fast to the leaf, so that it pulls out of the finished leaf readily and leaves the latter without support for attachment in assembling. In small leaves with wide bases, sometimes no stems are necessary, the leaves being simply stamped and cut out and sufficient waxed paper left at the base for attachment.

A long strip of the crêpe paper, either plain, or shellacked and self dried, is made into a roll and held in the right hand, while the loose end is dipped and immersed in the hot wax. Several inches more than is required actually to cover the mould should be dipped, as when the paper is quickly drawn out of the hot wax the latter runs down and gives a thicker body at the bottom of the paper out of which to stamp the leaf impression, and the excess of wax holds the heat longer. As quickly as possible, the waxed paper is laid in place on the mould, the paper released, the press lever grasped with the left hand, thrown smartly down on the wax, grasped also with the right hand and held down hard for a moment to give definition. In a few moments, the lever is raised, bringing with it both halves of the mould with the waxed paper clamped between them. The lower mould is taken off, and the wax leaf is gently removed, cut from the roll or sheet with scissors and thrown into a basin of water containing a little washing soda to cut the oil.

Better definition may be had from warm than from cold moulds, and it is a good plan to arrange moulds that are wanted for immediate pressing upon a wire-screen shelf suspended high enough over the wax pot to be out of the way in manipulating the press. In pressing one leaf after another, the mould soon warms up of itself, and for this reason with cold moulds the first few impressions are not so good as subsequent ones.

Different leaves require different treatment. Moulds that have deep modeling or definition require a greater body of hot wax out of which to stamp the leaf in order to reach all parts and fill the mould completely and turn out a perfect leaf without blank spots. This is accomplished in several ways. One method is to paint hot wax on either the face or back of the mould, using a flat two-inch bristle brush. The wax, for the face, may be a darker color than the back, or in making autumn leaves it may be several colors, stippled on. This should be kept away from the edges as much as possible in order to produce a thin edge in the finished leaf. Another method is to use two thicknesses of paper, dipped and pressed at the same time. The more thicknesses of paper that are used in pressing, the thicker and stouter the leaf, but also the thicker the edge. One layer may be shellac-dipped and one not, and these may be of different colors—darker for the face and lighter for the back. Or one layer may be paper, plain or shellacked, with a sheet of split sheet cotton dipped and pressed with it.

A good method of making fine leaves is to press a sheet of cold wax on the face of the oiled mould with the fingers, lay on the stem, and then press with paper dipped in hot wax as usual. To reproduce leaves with a light colored midrib or center, like willow, the sheet of dark colored wax for the face side is cut in half and pressed into the face of the mould with the fingers, the two sheets being arranged in a long V-shape, so they are separated at the base and closed at the tip. A light stem and light colored waxed paper are then pressed, hot, as usual, the result being a light colored center, or midrib. Colored veinings for autumn or other leaves may be produced by swabbing oil color over the back of the mould and wiping it off carefully with a cloth, leaving the color down in the vein depressions. When pressed, the color comes off on the backs of the wax leaves and when allowed to dry gives a fine effect. The same result may be gotten by using hot colored wax in the same way in some instances, and fine effects may be produced by using different colored wax on the various colored papers, as for instance red or yellow wax on light green paper gives red or yellow veinings. In this way a great variety of color effects may be produced that are purely mechanical, but which would take no end of time to paint by hand.

Sheet wax of various colors may be found for sale at art

tores. Mrs. Mogridge used a hand machine for shaving wax in all her work, the machine being constructed as follows: A wide blade, like a carpenter's plane iron, with an upright handle, sliding in two long tracks or grooves at the ends of the blade, passes back and forth over a block of warm colored wax fastened to a square sheet of iron screwed at the corners to a board below. The block may be fastened, or soldered on by heating the sheetiron plate, adjusting the wax block, and thus melting the bottom of the block which, when cold, holds fast. The board is raised or lowered by two long, loose wedges lying flat underneath the wax board, the bases of the wedges being opposed and separated. A long screw-bolt at one end forces one wedge upon the other, and as the wedges come together, they raise the wax board, more or less according to the number of turns made on the screw. The blade, pushed along the top of the cake of wax, like a plane, cuts off a shaving the full length and breadth of the cake. In this way wax may be shaved to any required thickness, and as the edge of the knife compresses the particles of wax in shaving, the sheet wax is tough and firm.

Another method of making sheet wax, by casting, is to sand-paper a piece of thin board until it is perfectly smooth. Soak the board for several minutes in warm water containing a little soap, olive oil, and glycerine, and dip the board into hot colored wax. Allow the wax to cool a little, cut around the edges, and lift off the sheets of wax. The board may then be again wet and dipped. The warmer the board and the wax, the thinner the sheet of wax. A glossy surface on one side of a sheet of wax may be made by substituting a plate of glass for the board, applying the water solution with a wad of cotton to both sides and then dipping the glass in the same way. The shorter the duration of the dip, the thicker the resulting sheet of wax.

After the leaves have soaked a few minutes in water to remove the bulk of the oil, they are placed on a wire-screen tray to dry, when the leaf is cut out or trimmed with scissors, these varying from fine-pointed scissors to shears, according to the size and form of the leaf. The general form of the leaf is first assured, and then the notching or edging of the natural leaf imitated with pointed scissors, or a hot bevel-edged iron or aluminum tool with a wooden handle as in Fig. 8.

If the notching is regular and fine, as in a rose leaf, the warm notching tool alone is best. Simply touch the edge of the leaf with the hot iron, making a slight notch, and continue thus all around the leaf. If the notching be coarse or large, with fine-pointed scissors snip all around the edge of the leaf as shown in Plate XXVII, Fig. 1, and break off the cut ends as in Fig. 2. Irregular notching is done with the scissors, cutting out the larger notches and breaking off the smaller ones. In some cases only the larger notches require cutting, the smaller ones being reproduced by the use of the notching tool. A variety of notching will be found in different species of leaves and these must be imitated. For example, the circular notch of a chestnut leaf is difficult and tedious to cut out with straight-bladed scissors. Curved scissors will here be necessary. Another method of making a circular notch is to

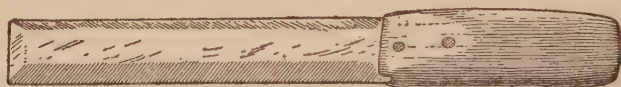


FIG. 8.—NOTCHING TOOL.

punch the edge all around with a harness maker's punch, thus imitating the curved base, and then snipping with fine scissors to complete the notch.

When the notching is completed, to perfect and thin down the edge of the leaf, the extreme edge, all around the back, is rolled or flattened by laying the leaf on the forefinger of the left hand and rolling it with the head of the modeling pin, as shown in Plate XXVII, Fig. 3. Be careful that the extreme edge only is rolled, as rolling too far from the edge destroys modeling detail in the leaf.

When the notching and rolling are completed, the base of the leaf, at its juncture with the stem, is pressed hard with the side of the modeling pin to secure a neat union and to bind all firmly together at this point. Worm or insect holes are imitated by cutting out holes with the pointed scissors or punch, and running a hot wire around the inside of the hole to give an irregular worm-eaten outline, as in nature, such holes being generally colored brown or reddish on the edges.

The coloring of the leaves will depend somewhat upon what they are. Ordinarily a number of leaves are laid flat on a wire-cloth tray, the latter tilted up a little, and the leaves sprayed with

an air brush, using coal oil and tube oil colors. Another method, where the air brush is not at hand, is to use a "dauber," made by wrapping a wad of absorbent cotton in a piece of cheesecloth and dipping and rubbing the wax surface with oil color, using a minimum of color and rubbing it in well. Some leaves are best colored after they are assembled and mounted upon the branch or bush. In this way much better distant effects may be gotten, as the end or side of a spray or branch of leaves may be made lighter or darker than another. Autumn leaves should always be done thus, so that one area may be made yellower, greener, or redder than the other. If colored first and mounted indiscriminately, a mottled and speckled effect only is secured. A combination of the two methods is good; that is, coloring the leaves generally at first, then changing or varying the coloring after they are assembled and mounted. Final spotting or blotching is done by spattering or by the use of a small artist's brush. Leaves with a polished surface, like the English ivy, may be imitated by polishing the surface, after the paint is dry, with a wad of cheesecloth or a soft brush such as is used for brushing the hair of infants, blowing the breath upon the leaf to warm and moisten it while polishing. A high gloss may be secured by spraying or painting with white shellac. Dull effects may be had by dusting or spraying with dry white or yellow dextrine, plaster, or flock before the paint is dry. These may be tinted by grinding them in a mortar with dry color. If the oil color with which the leaves were painted be dry so the powder will not stick, spray or paint with gum arabic diluted with water and then dust or blow on the dry color. Liquid rubber may also be painted on, and when half dry, dusted with the powder colors.

Very large leaves, such as fully-grown sycamore or rhubarb, are difficult to make in wax, as it is next to impossible to keep them thin enough to look well and at the same time have sufficient body and strength to hold up. Such leaves are sometimes cast in not wax, but unless the subject be naturally thick and heavy, wax is not a very satisfactory medium in which to represent such objects, and the celluloid process later described should be substituted for it.

To make a wax cast of a long sword-like leaf, like the century plant or the Sansaveira, the natural blade is cast in plaster in a

two-piece mould as usual. When dry the moulds are oiled with boiled linseed oil, wiped dry, and followed by a slight oiling with salad oil. A long piece of wire mosquito netting is cut and bent so it fits snugly inside the mould, keeping away from the extreme edges. A sheet of dry light green crêpe paper is laid in over this, overlapping the side of the mould. The two halves of the slightly warmed mould are then put together and the mould poured full of hot green wax and paraffine, enveloping the netting and saturating the dry paper. When cool, the mould is taken apart and the cast relieved. The wax blade is then trimmed, the knifelike edges being reinforced with the paper which was placed in the mould. For some objects, wax casting from a plaster mould is not entirely satisfactory, and wherever possible the glue-formalin mould should take its place. Furthermore, by this method of casting wax from plaster, so much oil must be used to keep the wax from sticking to the plaster that the oil combines with the surface wax and softens it. This, of course, dries out in time, but the wax must be handled carefully while fresh to avoid injury to the surface.

Celluloid Leaves.—Instead of wax for large leaves, liquid celluloid is much better adapted, as when dry it holds its form and sufficient flexibility. Celluloid leaves are cast from double plaster moulds, as in making wax leaves, but no press is required as each half is cast separately and the two afterwards cemented together, back to back. Plaster moulds of the face and back of the natural leaf are made as already described and set aside to dry, but not soaked nor painted with linseed or other oil. When the plaster is thoroughly dry, the moulds are painted on the faces with Le Page's liquid glue thinned down with a little water, two or more coats being applied until a good even gloss results when dry. Two or more coats of dilute glue are better than one coat of thicker glue. The moulds may be placed in the sun or near a fire or radiator to facilitate the drying of the glue, if in a hurry.

Liquid celluloid (Formula 8) is then colored with a very little tube oil color, making a light transparent green for ordinary leaves. Flow or paint the surfaces of the moulds with the colored celluloid, allowing the liquid to drain and not settle in pools in depressions of the mould. Set aside, generally tilted at an angle, for the celluloid to dry. The drying may be hastened by artificial heat. When dry, flow or paint again, and repeat the alternate drying and

ainting three or four times until the mould is evenly covered all over. When dry, lay on a sheet of dry sheet cotton, previously split in two, laid flat on the table and the excess of loose cotton taken off with a flat toothbrush, and laid on the mould smooth side up. Paint clear, uncolored liquid celluloid on the dry cotton, using a soft brush, settling the cotton into every depression of the mould, and set aside over night to dry out. Very large leaves may have two or three coats of celluloid over the cotton, and in some instances two or more layers of cotton may be used.

When dry, set the moulds in a pan of water a few hours, then, owing to the liquefaction of the glue on the surface of the mould, the celluloid casts lift off readily. Rinse both the celluloid cast and the mould under a faucet to wash off the glue and set aside to dry. Make a stem, as in wax leaves, by winding a fluff of cotton batting around one or more thin wires bound together with the cotton and dip it in white shellac. Paint the backs of the celluloid casts with white shellac and allow it to remain a few moments to become gummy. Place the face cast of the leaf back in the mould it came out of, adjust the stem as in wax leaves, and place the other celluloid half-cast in position on top of all, pressing it with a cloth and the fingers. After remaining in the mould half an hour to allow the shellac to harden a little, remove the leaf from the mould and work it into the back half of the mould, seeing that no air bubbles exist between the two celluloid casts. Allow the leaf to remain in the mould with one mould off to allow the shellac to dry. The alcohol in the shellac renders the celluloid soft and flexible, and at this stage the leaf may be taken out of the mould entirely, supported in the position the finished leaf is to assume, and allowed to dry this way. Several days will be necessary for drying large leaves. The edges are notched with scissors as in wax leaves. To thin down the edges, after the notching is finished, paint the edge with amyl acetate, acetone, or alcohol—or a mixture of them—and while the celluloid is soft, roll the edge as in wax leaves.

Some moulds may be painted over with green celluloid and while wet covered with the cotton and then more colored celluloid. This is quicker and very good provided the leaves are not to be exhibited in transmitted light, as the little balls or matted spots in the cotton hold more of the colored solution and thus give greater density and an uneven appearance when the leaf is held up to the

light. Hence the desirability of putting the cotton on dry colored celluloid and then painting with uncolored liquid. Another method of securing a good effect for transmitted light is to cast the leaf in uncolored celluloid throughout, and, before they are put together, to spray the inside surfaces with green dye and allow this to dry before shellacking. Still another method is to place a sheet of green shellacked crêpe paper between the two halves, using this instead of cotton for reinforcement of flat leaves.

Varicolored leaves may be made by using liquid celluloid of different colors, side by side or one over the other. To produce a green leaf with red veinings on the back, paint the back mould with red liquid and wipe off with the fingers covered with a piece of soft cloth, wiping off the celluloid from raised surfaces and leaving the liquid in the channels or veinings. Amyl acetate or acetone on a cloth may finally be used so as to produce clear-cut veinings in the finished leaf. Allow this to dry thoroughly and in large leaves the process will have to be repeated two or three times to insure full plump veins, as the liquid shrinks in drying. When dry, paint or flow with green celluloid, followed by the cotton reinforcement as before. Light green, yellow, or any desired coloring for veins may be done in this way. Celluloid veinings may be put in, allowed to dry, and the leaf be pressed in wax in the usual way and the mould soaked in water to relieve it, thus producing a combination wax and celluloid leaf.

When dry, the celluloid leaves are painted as with wax leaves, or they may be sprayed or painted with water dye dissolved in a minimum of boiling water and then diluted with acetone or alcohol and strained. Liquid colored celluloid may also be painted on the surface of the finished leaf, provided too much be not painted on at once, as fresh celluloid painted on softens the leaf and too much destroys the form and detail by shrinkage in drying. Beautiful effects may be produced by thus placing one color over another, allowing each coat to dry thoroughly before applying another, and sometimes wiping off one color while fresh and leaving it only in the low places. This method works especially well in making artificial fruit and flowers. For flower petals which are to be modeled, cut up white wax and stir it in liquid celluloid until the wax is dissolved. Don't heat the mixture. Keep it cold, or the two will separate. Color with dye or oil color as desired. Dip crêpe or

sue paper in the cold wax-celluloid mixture and pin it up to dry. Cut out petals or small leaves and model them with the modeling knife in the same way as in making wax petals. When dry, these will hold their form and not droop with ordinary heat. If it is desired to change the form of a dry celluloid leaf, paint it with acetone and, while soft, remodel it. Artificial green grass is easily made in this wax-celluloid material and when dry holds up stiffly.

The addition of gum copal to liquid celluloid makes a more viscid liquid and adds bulk, and is therefore an advantage in casting celluloid leaves, as fewer coatings are required. Grind up the gum in a mortar, add it to the celluloid and stir occasionally until it is dissolved. After straining through cheesecloth, the liquid is ready for use.

Foliage or other objects made in celluloid should, of course, be exhibited under glass, not only on account of dust, but also because of their great inflammability. Noninflammable celluloid may be used to obviate the latter difficulty, but is hardly necessary if reasonable care be used. Celluloid products are used all over the civilized world and it is rare that any of them are ever destroyed by accidental fire in the hands of intelligent people. Ammonium phosphate, dry, ground up fine in a mortar, may be stirred in the liquid celluloid and the latter when dried out will be more or less fireproof or noninflammable according to the quantity added. The cotton used for reinforcement may also be fireproofed by spraying it with the fireproofing formula given in the following chapter.

Assembling and Mounting Foliage.—The method by which a leaf is to be mounted or attached to the twig depends upon the growth. If the twig is soft and transparent, like most succulent seed stalks, the stalk itself must also be made up artificially, and the leaves welded fast to it. For a foundation, wire of various sizes is used, generally beginning with a thin wire for the tip or apex and adding others to enlarge and stiffen it as the stalk is built down toward the base. The wires are wrapped with absorbent sheet cotton and then dipped into a tube of cooling wax, the wax allowed to cool and dipped again, and the process repeated according to the thickness desired. After the first dipping they may be rolled on the table with a flat stick to smooth them. Leaves, etc., are bound fast to the wire by their supporting stem wires, using a strip of waxed paper, crêpe, or thin cloth as binding. This may

be painted with a hot wax, or it may be dipped again according to circumstances, and smoothed by rolling and twirling with the fingers.

The character of the growth and disposition of the leaves upon the main stems must be determined either from a fresh model, or in default of this, by a dried or a pickled specimen, a photograph or drawing. Some leaves grow singly, some grow in pairs, and some in threes all on one soft stem, and this grows out from the woody portion or twig of the bush or tree. If upon a twig, drill a hole through it with a three-cornered needle set in a wooden handle, and pass the wires projecting from the base of the stem through the hole, as in Plate XXVII, Fig. 4. Touch the wax at the point of contact with the wood with a little liquid glue, draw the stem-base up hard against the wood, snip off the excess wire on the reverse side, and bend and flatten the ends tight against the wood.

When the leaf itself grows directly upon a woody stem that is large enough and stout enough to support the leaves that are to be placed upon it, the twig is drilled and the leaf attached directly to it in the same way. In all cases, simply make up or restore the perishable portions. All branches that are to be used for the attachment of artificial foliage should be soaked for several days in a tank of glycerine and water of about equal parts to keep the bark and twigs from drying and becoming brittle. These should always be sawed off from main branches, if too large to handle in one piece, and afterwards doweled fast, glued, and the joints made up with mâché and color. In some instances, if bark or twigs have a shriveled look after drying, they may be painted with clear or colored wax diluted with carbon tetrachloride and used hot, to plump them.

Casting Fruit.—The exhibition of processed fruit and flowers in glass jars in a liquid solution, like the Chamber of Commerce exhibits in many cities, never appealed to me. The colors generally are not accurate, neither are the specimens permanently preserved. One good dish of wax or celluloid fruit is better than a dozen jars of processed vegetable material, so far as a real exhibit and an illusion are concerned. In the first place, one is not used to seeing flowers or fruit growing in water any more than one is accustomed to beholding ordinary fish swimming about in the air.

Furthermore, the glass jar distorts badly and in many cases is filled with reflections, rendering the whole exhibit hardly worth while. Artificial fruit, if carefully done, may be made so realistic as absolutely to deceive the eye, and if it must be displayed in a jar of liquid, a simple method is to place the wax fruit in a jar with water. The usual methods of duplication are by casting either in wax and paraffine or in celluloid, and the mould may be made in plaster and formalin, or in plaster. For an illustration of the use of a plaster mould and celluloid cast, we will proceed to reproduce an orange.

A piece of flexible cardboard is cut with parallel sides long enough to make a circle about half an inch larger than the circumference of the orange, and half an inch deeper than half the diameter of the orange, allowing enough to lap over at the end for sewing with needle and thread. Place it flat upon a piece of paper pinned on a board, and drive a few pins through the base of the cardboard circle into the base board to hold it firmly, and fill the crack around with plasteline.

Run a small pointed wire through the center of the stem area of the orange and out through the center of the other side, allowing the wire to project an inch on either end. Place the orange in the cardboard cylinder, the wires resting on the upper edge of the cardboard and thus holding the orange suspended on a wire axle, the sides being equidistant all around and the bottom of the orange about an inch or so from the paper below.

Paint one half of the orange with plaster, roll it over plaster on a board, and pour in liquid plaster until it comes up even with the rim of the cylinder all around. An artist's brush and water may be used to true the edges while the plaster is still liquid. After the plaster has set, key the top edges with a twist drill and remove the cardboard cylinder. Cut another piece of cardboard wider than the first and tie it tightly around the plaster so the top edge will be half an inch higher than the top of the orange. Paint the top edge of the plaster with clay mixed and thinned down with water, as oil is better left out wherever the dry moulds are subsequently to be placed in water to relieve a wax or a celluloid cast. The plaster absorbs the oil and waterproofs it, thus preventing the entrance of water to liquefy the glue and free the cast. Paint the exposed portion of the orange with plaster to kill bubbles and pour

the cylinder full of liquid plaster. Give it plenty of time to harden, remove the cardboard, and wedge the moulds apart and set them aside to dry. When perfectly dry, paint the edges and inside with thin Le Page's liquid glue until a good gloss results when dry.

Mix cadmium yellow and orange oil colors with liquid celluloid (Formula 8), putting in only a small quantity of color so as to leave the celluloid transparent. Flow the inside of the mould with the colored liquid, rocking the moulds about so the celluloid is evenly distributed, and drain off the excess into the bottle of liquid. It saves time if the liquid celluloid be allowed to evaporate until it is quite viscid and syrupy, the evaporated mixture requiring fewer coats. Set the moulds upside down on a piece of wire netting raised from the table to allow for drainage and also so the air can circulate freely and dry the liquid. When the celluloid ceases to flow, wipe off the edges, set the moulds upon their sides and allow the coat to dry. If a part of the orange is to be represented as greenish in color, due to immaturity, stipple in some light green celluloid and allow this to dry, then flow again with yellow liquid. When this is dry, paint again and while this coat is wet, dust all over the inside with dry mill dust or "flock" shaken from a tin can arranged like a pepper shaker, blowing out the excess. This reinforces the celluloid, and alternate paintings with celluloid and dustings with fine mill dust or sawdust make the cast very strong. For a final reinforcement and to allow for fastening the two halves together when they come out of the moulds, split sheet cotton is torn into strips half an inch wide, placed in the mould, and painted with celluloid, the dry ends of the cotton overlapping on the edges of the mould all around.

When bone dry, which may take two or three days according to the temperature and thickness of the cast, paint the inside with wax and paraffine, hot, giving a good substantial coat. Bend the loose ends of the dry cotton inwards all around so that when the two halves of the mould are put together the cotton from one side touches the other. Place the assembled mould on the floor, put the foot upon it, and press firmly to insure a good union. Open the mould and pour into one side a quantity of hot wax mixed with paraffine, set the other half in place, hold it firmly, and rock about in all directions, thus depositing the wax evenly all over the inside and saturating and uniting the dry cotton of the two halves so as

to keep the latter from separating in the finished cast. As soon as possible after the two halves are in place, force a small wire into a hole previously drilled in the stem area of the orange, and draw it out again, repeating this to keep the hole open while rocking the hot wax, to allow for the escape of the hot air. Without this precaution, when cooling, a section of the wax interior is liable to collapse, draw away from the celluloid coating, and leave the latter without any wax reinforcement.

When the wax has cooled sufficiently so that it has ceased to flow, immerse the mould in water and allow it to soak a few hours. From time to time, insert a knife blade in the mould slot and pry slightly to assist the entry of the water between the mould and the cast. When the moulds show a disposition to loosen, pry one half off, exposing the celluloid orange. Allow the other half to remain in the water another half hour and gently coax out the orange. If the halves were exactly centered there will be no difficulty, but if in casting one half was made larger than the other, the larger half will stick, and the mould must be broken away at the edge to relieve the orange, and will thus be of no use for casting a second one. After the orange is out, wash it and the mould under a faucet of running water to remove the glue, and set both away to dry. If carefully handled, many such casts may be made from the same moulds. Wax fruit may be cast from warmed plaster moulds, after they have been painted with glue and dried, filled with hot colored wax, and then soaked in water to relieve, exactly as in making celluloid casts. But for wax casting, much better definition may be had from a warm gelatin-formalin mould.

The mould joint on the celluloid orange is trimmed with a sharp knife and scraper, painted with orange wax, and planed down with the finger nail until it is entirely obliterated. A wire wrapped with cotton dipped in hot wax and placed inside the orange through a hole bored in the stem area answers for a stem. A good fluff of cotton should be left at the end of the wire, so when pressed firmly against the base of the inside of the orange, it offers a firm support. A little hot colored wax painted on the stem fixes it firmly. The outside may be painted or sprayed with oil color, or colored celluloid may be used provided too much of the liquid be not applied at one time so as to soften and warp the hard surface. If used as a spray, celluloid may be thinned or reduced with acetone. Smooth-

coated fruit, such as apples or cherries, may be painted, or dipped quickly in colored celluloid an indefinite number of times, provided plenty of time be allowed for drying between coats. By using one colored coat over another of a different color, fine effects may be produced. Celluloid painted upon wax takes some time to dry, but the liquid combines with the wax and softens it. Varnish or shellac may be used as a finish glossy coat for certain fruits, and the "down" on peaches may be represented by blowing on "flock" over the finish varnish or shellac or liquid rubber. "Flock" may be purchased from dealers in milliners' supplies, or a good substitute may be made by sandpapering white blotting paper and using the resultant dust. For some purposes, sifted mill dust answers the purpose very well.

Glue-formalin moulds (Formula II) may be used in the same general way for casting fruit or berries, either in wax or in celluloid, but when celluloid is used, the mould answers for only a single cast or copy, and the mould is lost. But when casters' gelatine, mixed with glycerine is used without formalin for celluloid casts, the glue mould may be trimmed off, remelted and used an indefinite number of times. Celluloid casts are much more durable than wax and generally much finer definition may be secured with celluloid.

Various species of cactus are nicely represented by soaking the natural cactus in water to loosen the spines, pulling out the spines, making a wax or celluloid cast of the fleshy portion, and drilling holes and gluing the spines back upon the cast leaf or stalk. In making celluloid casts of objects like a cactus leaf, for the finest results remove the casts from each side of the mould, dry them and the moulds, trim off the edges of the casts, paint both the inside of the moulds and the faces of the casts with liquid glue, and glue the casts back into the moulds again. Then run the mould full of hot wax and paraffine and set it into water to cool and loosen the cast again. The object in doing this is to prevent the hot wax from running on the outside of the celluloid cast, between it and the mould, which might happen if the thin celluloid cast were not glued tightly to the mould. This is sometimes tedious work and if large quantities of cactus are to be made, is expensive, so that cleaning out the interior and pickling the natural cactus is preferable for large groups.

Modeling Flowers.—In a work of this character it is not considered necessary nor advisable to take up in detail the methods of modeling many nor complicated flower forms. Instructions are given for the modeling of a few simple flowers to give the reader a general idea of the methods of procedure. Most artificial flowers are manufactured by making up the different parts separately and afterwards assembling or welding them together to make up the whole. As these flowers must be exhibited under glass in a museum to protect them from dust and vandals, wax is generally used, being the easiest medium in which to model them successfully.

Much success has been attained in the modeling of certain flowers and marine animal forms in glass. But this requires certain apparatus and technique of which the author has no knowledge. One lifetime is much too short in which to investigate all fields of research in which a person might become interested. This is an age of specialists and it is much better for a person to become proficient and expert in one line, rather than be a "Jack-of-all-trades and master of none." This is true in taxidermy as well as in medicine and law, and it is a rare thing to find a preparator who is an expert in bird mounting who knows or cares anything about mammals, and *vice versa*. In most museums the accessory department is separate from the taxidermy and each has its own trained preparators working in conjunction with each other; but to become proficient in making groups in which modeled plants and flowers are used, the finished taxidermist to-day should be able to make his own accessories so that he could go into the field and collect his own specimens of animal and plant life,

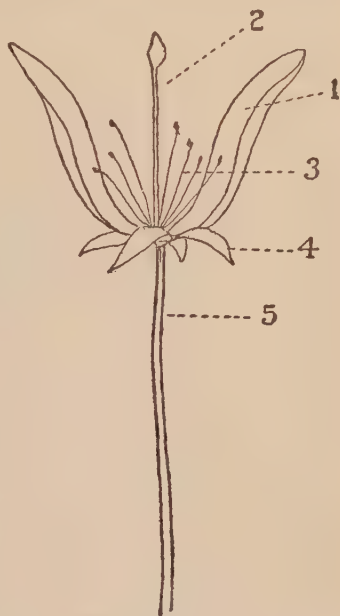


FIG. 9.—DIAGRAM OF A FLOWER, SHOWING THE PARTS.

1. Petal. All the petals together are called the corolla.
2. Pistil. The tip is called the stigma and the body the style.
3. Stamen. Composed of the anther at the tip, and the body of the stamen which is called the filament.
4. Calyx. Composed of several sepals.
5. Stalk, or stem.

bring them back and prepare both for exhibition in the finished group. Such a man is invaluable to any museum.

Modeling the Violet.—A few fresh violets being before us to serve as models, their stems in a glass of water containing a little salt, to keep them fresh for a time as the work proceeds, flower is selected and pulled apart to see how it is constructed. For our purposes, we find it composed of a center, calyx, a bag-shaped affair at the back, and five petals, the latter being of two sizes and form, one large and four smaller ones, as shown in Fig. 10.

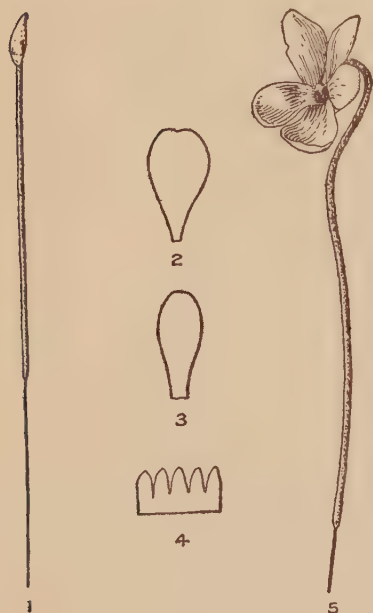


FIG. 10.—DIAGRAM FOR VIOLET.

For patterns of the petals one of each size is laid flat upon a piece of white paper and pinned down, and a little water-color paint of any dark color is stippled over the petal with a flat-ended stippling brush. When the petal is removed we have a stenciled outline of the shape of the petal, and after this is cut out with the scissors a perfect pattern is secured from which to cut wax duplicates. If a number of flowers are to be made, duplicates of these paper patterns may be cut and filed out of sheet tin, if something more durable than a paper pattern is desirable. If a great number of petals are to be made, it is a great

economy and time-saver to take the paper patterns to a die maker and have him make a steel die of each size. Wax petals may then be stamped out quickly, like cutting wads with a wad cutter, stamping or cutting upon a sheet of rubber gasket packing tacked fast to a block of wood. By keeping this and the die moist, to prevent the wax from sticking, enough petals for a good many flowers may be stamped out in a short time. Simple "homemade" dies for this purpose may be easily made by taking the temper out of a piece of hack saw blade, grinding the edge sharp and smooth, bending it into the proper form and retempering it. Petals for apple blossoms and many small leaves may thus be stamped out with im-

provided dies which take but a short time to make and which will save hours or days of tedious work cutting them out with scissors.

By a glance at the natural petals, we find that they are white at the base. This means that the wax petals must be cut out of white material. White crêpe paper, pulled and stretched to get rid of the crinkle, is dipped in hot bleached wax, tempered with rosin and linseed oil to soften it, with the addition of flake white color. If too much white lead or zinc oil color be added to hot wax to whiten it, it causes the mixture to froth. This forms or deposits bubbles on the dipped paper or cloth, and ruins it. A kettle of wax that acts this way should be strained a couple of times and more clear wax added, to save the batch. A little borax, dissolved in a minimum of water, added to hot wax whitens it nicely, and this may be supplemented by the addition of a little tube white, to produce a good white colored wax.

The paper having been dipped and the wax petals cut out according to the patterns, violet and a little Chinese white (zinc oxide) powder colors, are mixed together, dry, a wax petal taken up by the base between the thumb and forefinger of the left hand, while with the thumb and forefinger of the right hand, the dry color is rubbed on the petal, being careful that none of the powder touches the base, as this is white, and the powder would also keep it from sticking fast later in welding the parts together. The color is previously tested on a small piece of white waxed paper and matched up by comparing it with a natural petal. Arrowroot is also used, alone or in combination with dry colors, sometimes being rubbed on with the fingers and sometimes stippled on with a fluff of dry absorbent cotton. The fine reddish-violet lines on the insides of the bases of the petals are painted on with a fine sable brush, mixing a little water with the dry color for this purpose, or using Winsor & Newton's pan colors. The petals are modeled into proper form by placing them in the palm of the hand and rolling them with the head of the modeling pin.

The petals are now finished. These are laid aside and the center made up, as follows: A tube of hot wax of the proper stem color is prepared, and while cooling, thin cotton or silk-covered wire is dipped, cooled, and redipped until it is of the proper size for stems. If no ready-prepared covered wire is at hand, ordinary wire may be wrapped thinly with absorbent cotton and dipped and then rolled

upon the table or upon a smooth board with a flat stick to smooth it. Subsequent dippings then go on smoothly. Wire of any size may be dipped and waxed without being first covered, but the cooling wax takes better and holds more firmly if the wire has a foundation covering. Cotton or silk-covered wire may be had from dealers in milliners' supplies. Wire may also be covered cold by wrapping a long narrow strip of sheet wax, waxed paper or gauze around it, and smoothing it by twirling and rubbing between the thumb and finger, and modeling with the side of the modeling pin. This method is necessary in assembling in many instances, but wherever possible, time may be saved and better results attained by dipping than by cold wrapping.

A piece of wax-covered wire long enough to represent the stem of the violet is now cut, and with the forceps, one end is turned back upon itself in the form of a short hook, and a little cold wax added, twirled, and modeled with the fingers into a round, pointed ball, as shown in Fig. 10. Turning back the tip of the wire into a hook makes a firm foundation and keeps the ball from slipping off in the finished flower. The tip of the ball is colored with cadmium yellow, using a small brush and pan water color. In using water colors, do not dip the brush itself into the water, as too much water is usually taken up, leaving the paint too thin. Dip the end of the brush handle in a glass of water, place the adhering drop in the pan of color, and then reverse the brush and mix the drop of water with the color, and apply the mixed color as usual.

The center now being completed, the petals are welded fast to it one at a time, picking them up by spearing them lightly with the point of the modeling pin, adjusting them properly and welding them fast by rolling with the side of the modeling pin. The little bag at the back is made by rolling up with the fingers a small ball of wax or waxed paper, and welding it fast with the pin.

In all processes of welding petals or other parts of a flower, wherever possible, in order to get a good strong weld, it is a good plan to use a warmed welding pin, afterwards touch the joint with a little hot wax applied with a sable brush, and smooth this with the warm tool. For warming tools, a candle, alcohol or kerosene lamp may be used, but it is a great convenience to have a small portable Bunsen gas burner, attached to a long piece of rubber tub-

ing, to be had at dental supply houses. This may be turned low and the gas consumption be made very light.

The natural calyx having been unrolled, pinned out flat, a stenciled paper or tin pattern made, and duplicates cut out of single or double light green waxed paper of the proper shade, this is modeled into shape in the same way as the petals, by placing it in the palm of the hand and rolling it with the pin head. The calyx is now wrapped around the base of the flower, using fine forceps and the modeling pin to adjust and weld it fast. A calyx, in some instances, may be made flattened out and then modeled and wrapped around the base of the flower as in Fig. 10; or it may be made in one star-shaped piece, modeled, a hole punched through the center, and the calyx slid up from below, the wire passing through the hole, as in the buttercup, Fig. 11. The corolla in some instances is also better done this way instead of having each petal cut out separately. The calyx having been welded fast, the stem is given its characteristic crook and the back of the flower touched up with pan water color paint, imitating the colors of the natural flower, when the flower is completed.

If but a few flowers are to be made, these take proportionately more time to make than a larger number, as patterns must be made for one flower which also answer for many. If a number of flowers of one kind are desired, the time may be greatly reduced by doing one thing at a time, as for instance making all the stems, then all the centers, petals etc., using dies for stamping out wherever possible.

Modeling the Buttercup.—As with the violet, a living buttercup is dissected or pulled apart to see how it is constructed. We find it composed of a small light green ball in the center, a number of stamens growing around it, five petals of uniform size, and a five-pointed calyx on the back. The center is first made up, as in the violet, by turning the end of a waxed stem wire back into a hook to keep the flower from slipping off, winding a small piece of light green wax around it, and modeling it into a ball of the proper size and form. The ball is pricked with the point of the modeling pin, to break it up into a number of fine points in imitation of the natural center.

Now for the stamens. A piece of chrome yellow waxed cloth or paper is made up to match the color of the natural stamens. A

strip of this, a few inches long and about an inch wide, is cut off one lateral edge folded back upon itself, and welded by pressing with the fingers. This is repeated, thus producing a thickened edge which forms the anthers when the stamens are made. With the scissors, clip the wax into fine strips, thus producing a number of fine stamens tipped with an enlarged head to represent the anther upon which the pollen, in the shape of powder color, is deposited. In clipping with the scissors, each cut is made as long as the natural stamen. The scissors are not allowed to close at the tips in making



FIG. II.—DIAGRAM FOR BUTTERCUP.

the stroke, as closing entirely would break off or distort the stamen. Cut with the rear part and center and not with the points of the scissors, moistening the blades from time to time with the tongue to keep them from sticking to the wax. The stamens are thus left all attached to each other by the uncut base of the waxed paper or gauze. The number of stamens in the natural flower is counted, and a section of the clipped strip that has the required number is cut off. This is laid flat on the left forefinger and modeled with the side of the modeling pin, thus giving the stamens the required inward curve that is found in the natural buttercup. This strip

is wound around the prepared center, as shown in Fig. 11. The stamens are arranged with forceps and each head or anther touched with a little cadmium yellow powder color mixed with water, to represent pollen.

The five petals are cut out from paper or tin patterns, using heavily waxed chrome yellow paper colored a deeper and brighter yellow by rubbing the petals with pure dry color. In many flowers it will be found that the pigment has not yet been made that will enable the artist to key up the artificial flower as bright as the natural one, when the fresh living flower is held alongside for comparison. But with the living flower absent, artificial colors or pigments appear brilliant enough. The artist who tries to depict a field of yellow mustard or buttercups with the sun shining upon them, will find his brightest yellows are like mud in comparison with the reality.

The experienced preparator or flower artist can cut petals, etc., by the eye alone without the use of patterns, but this comes only by long practice. After being colored, the petals are modeled in the palm of the hand with the head of the pin in the same general way as in making the violet petals, using living petals for form and giving them the characteristic curvature and undulations. They are then welded in their proper positions to the base of the stamens.

The flower is now ready for the calyx. This is better made in one star-shaped piece rather than in a flat strip as was done in modeling the violet. A small wax calyx is rather difficult to cut out with scissors from a paper pattern, so the following is resorted to. A circular disk of waxed paper is first cut out and a hole punched in the center. Five straight cuts are then made on the edge producing five points or corners as shown in Fig. 11. The points serve as guides in indicating the tips of the sepals, when the calyx is readily cut out by straight or curving cuts reaching towards the center. After being modeled, the calyx, all in one piece, is slid up on the wire to the base of the flower, the wire passing through the hole previously punched, and welded fast. A touch of hot wax where it joins the stem, and final modeling with a heated tool makes all secure. The gloss on the inner surfaces of the petals is imitated by painting with varnish or white shellac when the flower is completed. The buttercup leaves are made in the

same general way as grass, using paper or tin patterns for form and size, welding them fast to the stalk as in the natural plant.

White Clover Blossom.—White clover blossoms are very simple to imitate. But two colors of waxed paper or cloth are necessary—a pure white and a light green. By an examination of the natural flower, it will be found to be made up of a number of little white petals of different sizes, shaped as shown in Fig. 12.

After these are cut out, they are placed on the forefinger, after the manner of grooving grass blades, and with a large three-cornered

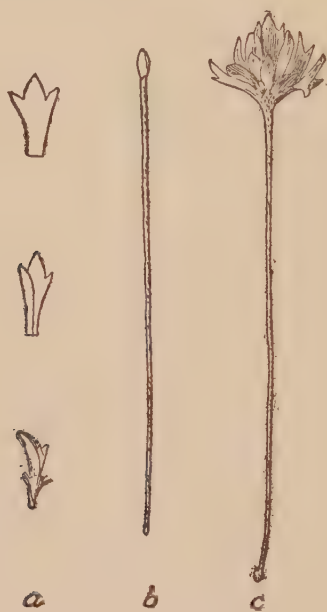


FIG. 12.—DIAGRAM FOR CLOVER BLOSSOM.

needle set in a handle, by pressure, two creases or lines are made in each petal, running lengthwise and on each side of the center. This leaves two "wings" and these are bent inwards along the creases which act as hinges, and the base cemented together and made round and solid by twirling it between the thumb and finger. The tip is now bent backwards by placing the petal on the finger tip and modeling it back with the side of the pin. Before twirling the petal, a piece of white pig bristle, cut from a coarse paint brush, may be enclosed in the center of the petal to stiffen it if desired. The fine stamens are made as already directed, by clipping a sec-

tion of green waxed cloth or paper with the scissors. This strip is then cut into small sections having the requisite number of stamens, and one of these sections is wrapped and twirled around the base of each petal, as in Fig. 12.

A small ball of light green wax on the tip of a wire stem serves for a foundation, and the petals are welded fast with the pin, painting on a little hot green wax wherever necessary and touching the spot with a warm tool, to bind the whole together and give strength to the flower. When completed, the lower petals are tinged with burnt sienna pan color in imitation of the living blossom which has been used as a model throughout the entire process. Red clover blossoms are made in exactly the same way, the tips of the petals being colored with magenta, or crimson lake mixed with cobalt blue, pan colors, mixed to match the natural flower.

In coloring clover leaves, to produce the light-colored kidney-shaped marking at the base of the leaf, the leaves are pressed in light-colored wax. A paper pattern the size and shape of the marking is laid on the leaf, and darker color sprayed around it, thus stenciling the leaf and keeping the color off the base which was covered with the paper pattern. The edge of the outline is then stippled lightly with a brush to destroy the sharp outline.

Making an Apple Blossom.—As with modeling other flowers, living blossoms are first procured to serve as studies. Stenciled patterns of the petals and calyx are made in the usual way, and from these, wax duplicates are cut or stamped out as shown in Fig. 13. The center is then made up. This is composed of a light green central spike, or pistil, surrounded by stamens. A wax-covered wire stem is selected, the wax stripped from one end with a knife blade for about half an inch, and after turning over the wire at the base to serve as a foundation to keep the flower from slipping off, the wire above the hook or knot is wrapped with a narrow strip of light green wax, put on lengthwise of the wire and strip, making a pistil of the proper size and length. The wax is allowed to lap over a little beyond the tip of the wire, and this loose waxed paper or cloth is divided and molded with the pin in imitation of the two lobes of the stigma.

Now for the stamens. Where the stamens in a flower are few in number, as in this instance, it is better to make them separately rather than snip them out of a long strip as in making the butter-

cup. Stamens may be made in a variety of ways. The white bases of moose or caribou hairs match the filament of apple blossom stamens almost exactly. But ordinarily silk or cotton thread, white or of different colors, run through hot wax and slipped through the pinched finger and thumb to smooth it, answers for stamens. The thread is then cut into sections of the proper length, the tip bent over into a hook with fine forceps, and dipped into a little cooling yellow wax, or the wax may be painted on hot, thus tipping the stamen with a little yellow ball to represent the anther. With

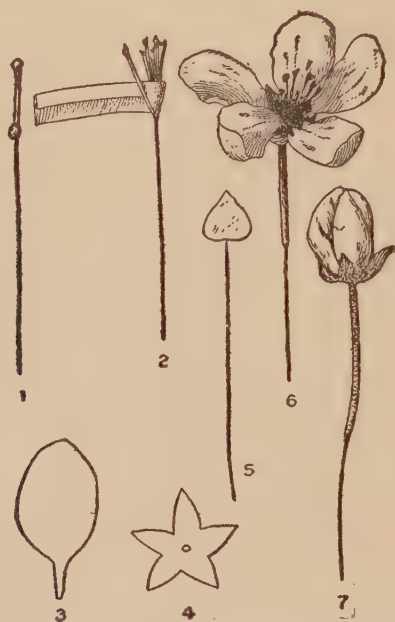


FIG. 13.—DIAGRAM FOR APPLE BLOSSOM AND BUD.

the side of the point of the pin, this ball is divided into two lobes and colored with orange and sienna pan color in imitation of the original.

The stamens, having been completed, are mounted on the body or stem wire in the following way. A strip of light green waxed paper or gauze is folded over lengthwise along one edge and welded fast, making one half the strip double thickness. With the doubled edge up, one end of the strip is welded fast to the base of the pistil. The strip is wrapped firmly around the pistil, and as the wrapping proceeds one stamen after the other is introduced as shown in Fig.

13, and bound fast until the required number have been inserted. The object in doubling one half of the binding strip is to produce a ball cut in half. If of one thickness throughout, after wrapping, a cylinder instead of a half ball would be made. The green half ball at the base of the stamens—which is really the embryo apple—is then smoothed and consolidated by rolling it with the side of the pin, when the center is ready for the petals.

The white wax petals are rubbed between the thumb and fingertips with dry arrowroot to kill the gloss and give the proper texture, and then laid in the palm of the hand, pressed hard with the thumb to dish or hollow them, followed by modeling with the pin head to give the proper curl in imitation of the natural petals. A piece of pig bristle may be inserted in the base of the petal and twirled with the thumb and finger to stiffen the petal, as with the clover. The bristle makes a good support and keeps the petal from lopping down afterwards, as often happens when this detail is neglected. The petals are then welded fast around the stamens by dipping the base of each one in hot white wax and welding it fast. A slight painting of hot white wax after all are in place strengthens the flower. A calyx is then made as indicated in the diagram, a hole is punched in the center, and after being modeled with the pin head, is slid up on the wire stem and modeled fast. A touch of hot wax over the joint makes all secure.

Apple blossoms vary greatly in color. Some open blossoms are pure white, while others are more or less blotched with red. The blotching is imitated with a sable brush and crimson lake pan color, and the color of the sepals varied by painting on darker shades of green. Small buds are modeled solid. Opening buds in which the stamens do not show, are constructed by modeling a solid wax foundation or ball on the end of a stem wire, as shown in the diagram. As natural apple buds are somewhat square-sided at the bases, the ball is made so. The petals are then made in the usual way and welded fast at their bases, and then the completed flower pinched between the thumb and finger to give the characteristic squareness.

To give a smooth red blush of color, as is found in opening buds, after the arrowroot is applied and before modeling, a very little dry crimson lake powder color is rubbed or scoured on with

the finger. In some instances, the dry color and the arrowroot may be mixed together and then applied as usual by rubbing the powder on with the tips of the thumb and forefinger. Color blotches may be painted over these pink buds as desired.

The "down" usually present in bunches of apple blossoms, is represented by first painting on a little dilute gum arabic, honey or raw rubber dissolved in carbon tetrachloride, and then sifting or sprinkling on dry flock and jarring or blowing off the excess. As the small leaves and the stems of the buds, blossoms, and larger

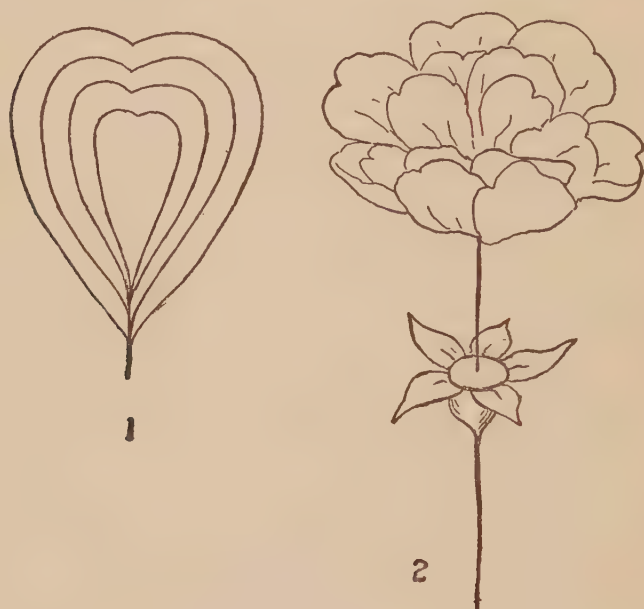


FIG. 14.—DIAGRAM FOR ROSE.

leaves are downy, the whole cluster of blossoms and leaves is made up or assembled, and the down put on. The bunches or clusters are then mounted upon the natural wood twigs by sharpening the latter with a knife, painting them with liquid glue, and binding the wires at the base of the cluster fast to the wood with strips of dark colored waxed crêpe, cut on the bias for strength. Papier-mâché, made up with liquid glue and containing a quantity of dry umber to match the twigs may be made up thin and painted over the joints to strengthen them. In this way, the whole branch is covered with leaves and blossoms, as was done by Mrs. Mogridge

in the exquisite robin group in the American Museum in New York many years ago.

Modeling Roses.—In order to get in the required number of petals so the rose will look solid and not be too loosely constructed, it is necessary to nest a number of petals inside of each other as indicated in Fig. 14, weld them all together at the base, and fasten the clusters to the foundation, rather than adjust each petal separately. After the petals are in place, the modeled

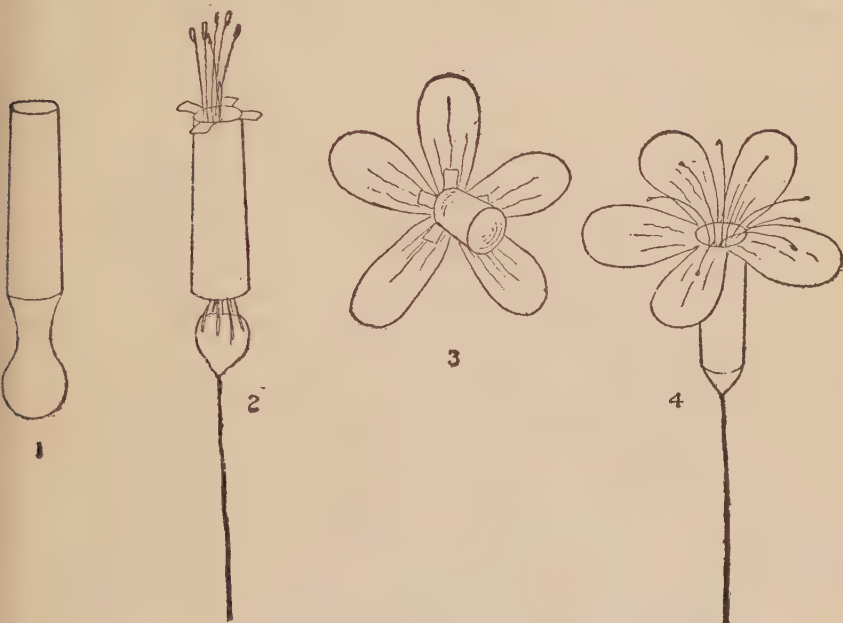


FIG. 15.—DIAGRAM FOR STEPHANOTIS TYPE OF FLOWER.

1. Wooden modeler.
2. Wax tube in position on the wax ball, with long stamens welded fast at base.
3. Tube in position on underside of corolla, ready for welding.
4. The parts welded together, completing the flower.

calyx is welded to the top of a half ball with a hole through the center, the end of the stem wire passed down through the hole, and the ball and calyx slid up and pressed hard against the backs of the petals, thus offering a good firm support and holding them rigidly in place, as shown in the diagram.

Flowers of the Stephanotis Type.—As the manufacture of flowers of this type involves another principle of making and welding parts, a diagram of the means by which these are made up is given in Fig. 15. To make the tubular base of the flower, a round

wooden modeling tool with slightly sloping sides, of the proper diameter and length is first made, as in the diagram. A strip of waxed material is cut to roll once around the wet tool, allowing enough overlap along the side for welding, which is done by rubbing it smartly with a warm tool. The wax cylinder or tube is then slipped off, and the top cut out with scissors and bent outwards as shown in the diagram. The corolla, all in one piece, is then cut out and a hole punched in the center with a harness punch. The tube is then adjusted to the under side of the corolla, with the flaring ends of the tube lying flat against the under side of the wax corolla. The two are firmly welded with the pin head and painted over with a little hot wax. A wax ball is then modeled on the end of the stalk wire, the ball being made of just the proper size to fit snugly inside the bottom of the tube. Single stamens are then welded fast to the ball and this is slipped up inside the base of the tube and the latter welded to the ball all around. The stamens projecting from the top of the flower are then arranged with forceps. The monkey flower is made in the same general way, over a wooden modeler, the tube being fastened in place over a wire upon the tip of which the stamens are attached.

The form and structure of flowers are so varied that it would be impracticable and not within the province of the present volume to attempt to describe them all. The general principles given here will enable the student or preparator to make a beginning, and other more complicated flowers will have to be dissected and methods devised for their construction. In some instances petals or parts will have to be cast, as in making leaves, either in wax or celluloid, and afterwards assembled.

In constructing bird groups, nests and eggs are often shown in order to illustrate the home life of the bird. For this purpose, the nest *in situ*, or where it was actually built by the birds, is best. The branch or sod upon which the nest is constructed should be cut or dug up and transported to the laboratory, where the perishable portions are restored.

The eggs are blown with the aid of the drill and blowpipe. These may be procured of dealers in taxidermy supplies. For small eggs, or for a start for the drill, a three-cornered glover's needle, set and centered in a wooden handle, makes an excellent drill. One small hole is drilled in one side—not both ends—of the egg, and the

blowpipe held close to the hole with the hole downwards, and by blowing stoutly with the breath, the compressed air that is blown into the egg forces out the contents. A mouthful of water is then taken and syringed into the egg with the blowpipe, thus washing out the inside. The blown egg is then placed, hole side down, on a fluff of cotton to dry.

Instead of blowing with the breath, a better method is to attach a bulb and hose to the end of the blowpipe and fasten the latter to a block of wood resting upon the table. The egg is then held hole side down over the turned up end of the blowpipe and the contents forced out into a bowl by squeezing the bulb. For large eggs, the blowpipe may be attached to a rubber tube connected with a foot pump or power air-compressor tank, such as are used for spraying with the air brush.

Eggs should be carefully kept in individual sets, marked with ink, and the data entered upon data blanks or in a catalog. Regularly printed data blanks may be purchased from dealers in collector's supplies. Sets may be arranged in cabinet drawers, either lying upon a sheet of absorbent cotton, or in cardboard trays with or without a glass covering to the tray. Eggs should be kept in the dark, as light quickly bleaches out the delicate colors and renders the eggs valueless.

To blow a badly incubated egg, drill, and mess up the contents with a piece of wire and inject pepsin and water, or water and carbonate of potash. Set the egg aside in a warm place to macerate for a few days, and remove some of the contents by blowing. Load the egg again and give it time to further soften the embryo, and repeat the process until the inside is blown out clean.

CHAPTER IX

GROUPS AND MUSEUM EXHIBITION

The modern museum demands two classes of collections—a research or study collection which is solely for the use of the student or specialist for comparison and scientific research; and an exhibition or display collection for the general public. The latter is a necessity, as in many cases it is the appropriation of public funds which keeps the museum alive.

In former days, exhibition collections consisted entirely of rows of mounted birds, mammals, and other objects placed in glass cases and, as a result the earlier museums were lacking in interest and were rarely visited more than once by the average person. He left without having been specially interested and without having received any distinct impressions, but rather with the idea of having viewed a conglomeration of objects of varying interest that taught him nothing. *They were part of a research collection placed on exhibition.* To be remembered and to have real merit, an exhibition must tell a story. Unless it does so, it is a failure.

A collection of research objects arranged in a glass case—as for instance rows of teeth of fossil animals, as exist at the present writing in one well-known museum—does not by itself tell any story nor possess any great interest for the average visitor. It is part of a research collection, and putting it in a glass case and exposing it to the public gaze does not make a popular exhibit of it. In connection with a mounted skeleton and a life-sized modeled “restoration” group of the animal, showing the appearance and something of the habits of the animals in their former environment so far as known at the present day, the case of fossil teeth might be made part of an attractive exhibit that would tell a connected story and thus interest and instruct the public.

In earlier days, curators of the various departments of a museum were men with scientific tendencies or training who rarely

knew or cared anything about exhibition. Exhibits were a bore to him. He was not an exhibitionist, and the "rows" were the very best he could do for the public. Happily for the growth of the museums of the world, this is largely changed and the heads of the departments of prosperous museums now recognize the fact that to stimulate the wealth and growth of the institution, popular exhibits must be installed and public interest created. The up-to-date museum now has its corps of modelers and artists, who are as necessary to its existence and proper growth as the scientific staff.

The keynote in popular exhibits of natural history was sounded by Mr. E. T. Booth of Brighton, England, about 1860. He constructed a series of groups, with artificially modeled and prepared accessories, showing the home life of British birds. These groups were bequeathed to the city of Brighton, where they now exist in the Booth Museum.¹

Somewhat similar groups of birds were later introduced into the British Museum at South Kensington, London. The flowers and foliage for these groups were beautifully modeled in wax and other materials by the late Mrs. E. S. Mogridge and her brothers the Messrs. Mintorn. These groups were very attractive both to the general public and to scientific men as well, as great care had been exercised to keep the groups artistically and scientifically correct. In some cases the actual sod upon which a nest had been found, was dug up and transported to the museum, where each individual growing leaf, flower, and blade of grass was duplicated in wax and other materials and arranged on the dried sod, exactly as in life. The late Mr. Morris K. Jesup, then and for many years afterwards President of the Board of Trustees of the American Museum of Natural History, New York, upon one of his periodical trips to Europe, visited the British Museum and was so charmed with these bird groups, that he invited Mrs. Mogridge and Mr. H. Mintorn to this country to prepare a similar series of local bird groups for the New York Museum, Mr. Jesup having arranged for their preparation with the late Mrs. Robert L. Stuart, who generously provided the funds. The late Jenness Richardson, at that time an assistant to Dr. W. T. Hornaday in the taxidermy department of the United States National Museum, at Washington, was

¹ See "The Story of Museum Groups," by Dr. F. A. Lucas; *American Museum Journal*, Vol. XIV, pp. 1-32.

selected to come to the American Museum and coöperate with Mrs. Mogridge in the collection and construction of the beautiful series of local habitat bird groups now on exhibition there. Aside from bleaching somewhat, due to daylight exhibition, these groups, after thirty-five years, are as good to-day as when first prepared and have long stood as a monument to the patience and skill of the preparators.

It will readily be seen that the art of making realistic modeled accessories had much to do with the introduction of groups in museums, for the crude milliners' leaves used in early days in group making were entirely inadequate, and as the art of making modeled accessories advanced, taxidermy kept pace with it.

When the series of bird groups in the American Museum was completed as originally planned, about 1890, Jenness Richardson, assisted by the author who was then an assistant in the department of taxidermy in that institution, began the construction of the group of bison that is on exhibition there in the J. A. Allen Memorial Hall. Upon the death of Mr. Richardson, the author was appointed chief of the department and was fortunate enough to induce Mrs. Mogridge to give him a set of lessons in flower and foliage modeling, Mr. E. B. Southwick and the author being her first pupils in this country.² The information gleaned from these artists enabled the author to construct the group of moose in the American Museum, as a companion piece to the bison group. The foliage in the moose group was prepared by the Mogridge methods. This was the first large mammal group in the world to be embellished in an elaborate way with modeled accessories.

Museum groups of mammals were started in this country about 1880 by Dr. Hornaday, who mounted and installed, while at Ward's Natural Science Establishment in Rochester, N. Y., the group of oranges on exhibition at the American Museum. This was followed about 1887 by the introduction of a group of coyotes and one of bison in the U. S. National Museum at Washington. These, however, were not embellished with carefully made wax accessories, this art not yet having reached that institution.

² In *The Art of Taxidermy* (D. Appleton & Co., N. Y., 1898), the author published in detail the methods of making wax leaves and flowers, as demonstrated to him by Mrs. Mogridge. The methods given there, like those in other branches, are almost entirely superseded in the present volume by new ideas and improvements.

Up to this time, no museum groups had been constructed with painted backgrounds, all having been made four-sided with glass all around. In 1901 Dr. Frank M. Chapman, curator of ornithology in the American Museum, began the installation of the bird hall of that institution. These groups were only one-sided and had artistically painted backgrounds and beautifully modeled accessories, the latter chiefly the work of Mr. J. D. Figgins, a former assistant to the author.

These groups once and for all demonstrated to museum administrators all over the world that one-sided groups with painted backgrounds and realistically modeled accessories, made the most pleasing and attractive bird exhibits. About this time Mr. C. E. Akeley constructed the magnificent seasonal groups of deer in the Field Museum in Chicago. These groups were carefully done with modeled accessories and painted backgrounds, the latter being the work of Mr. C. A. Corwin; and it is unfortunate for that institution that the work so well begun by Akeley could not have been continued there by him.

Other museums followed suit and soon fine groups of birds, mammals, fish, and reptiles were introduced; and the group exhibits installed by Mr. Figgins in the Denver Museum, in the Field Museum by Mr. J. Freiser, in the Brooklyn Institute by Robert B. Rockwell, in the American Museum by J. L. Clark, and in other museums, all give pleasure and instruction to thousands of people and redound to the credit of the institutions.

One of the chief faults with large four-sided groups is the reflection of objects in the plate glass of the group case, this being so bad in many cases that the visitor standing in front of a group can see his own reflection and that of extraneous objects better than he can see the group itself. The author has many times seen ladies stand in front of the moose group in the American Museum, and getting the proper position with respect to a dark colored moose, make a mirror of the glass and arrange their hats or clothing.

The theory of group case reflection is very simple, but is in some instances difficult or impossible to overcome. In large four-sided cases standing out on a museum floor—like the bison and moose groups in the American Museum, the groups in the U. S. National Museum, and many of those in the Field Museum—lighted with side windows in the building, the case is hopeless, as the windows

or other light-colored objects in the hall, being keyed up higher than the inside of the group cases, reflect in the glass. Black or a dark color behind a plate of glass makes a mirror of it to one standing in front, under ordinary side day lighting. The more light that is introduced into the case and the higher the inside key and the darker the outside, the fewer the reflections. A simply way of explaining this theory is for a person standing in an ordinary room to look out through a window in daytime. Owing to the strong light out-of-doors, the glass disappears. Now go outside and try to look into the room and the light conditions are reversed, the window is full of reflections, and it is impossible to see objects inside. When darkness sets in and the lights are turned on in the room, the conditions are again changed, so that looking into the room from outside, all parts of the interior and objects therein are illuminated and plainly discernible, and the glass disappears. If this principle be followed out, and if no extraneous objects of a higher key than the inside of the group case be allowed to reflect in the glass, the latter disappears so completely that unless railed off, visitors fail to notice the glass and bump their heads against it. These principles of lighting were carried out in the museum of the California Academy of Sciences, and no trouble from reflections was encountered.

Hence the desirability of one-sided exhibits under glass from this standpoint alone. From the standpoint of composition and grouping, by having but one front or view point, like a painting, greater freedom is allowed to concentrate upon one picture than if all four sides have to be taken into consideration and the group arranged to look well all around. The character of the country as illustrated in the background is also wanting in a four-sided group.

Tilting plate glass at an angle sometimes helps to throw down reflections, but the angle at which a very large plate of glass may be tilted with safety is limited. A sheet of plate glass fifteen by ten feet is very heavy, and if tilted too much and supported only at the edges, the weight in the center is too great, and the glass will crack in two, in the middle. Small plates may be tilted to any degree, dependent upon size; and glass-tilting may be of use in some instances, to throw down a reflection that can not be got rid of in any other way. Bent glass is sometimes used to stop reflections, as in store windows, but is apt to distort objects, and is also limited in



GROUP OF GOLDEN EAGLES, DESIGNED AND MOUNTED BY THE
AUTHOR

Background Painting by Maurice G. Logan

size. White plate glass should always be specified for group display and not plate glass with a yellow or green tinge.

The one-sided artificially lighted group with painted background is unquestionably the highest development of the group idea; and four-sided groups are now admittedly inadequate and old-fashioned. The latter served their purpose in the process of evolution of museum exhibits of this character, but modern up-to-date museum authorities now generally consider them as somewhat behind the times. A successful museum exhibit, like a book, should, as far as possible, tell a complete story. A better story may be told with a group which is supplemented with a painting for the reason that the general character of the country may in most instances be portrayed in the picture itself, and the specimens fitted into it. Without the painting, this must be left to the imagination of the visitor, and they usually fail to even try to imagine what the surroundings might have been.

Backgrounds and Groups.—In constructing a group, the size, of course, is the first thing to be determined. One of the worst faults in most museums is that where large objects are exhibited, the groups are made too small. In order to have atmosphere and a real out-of-doors effect, plenty of space must be allowed around the specimens. A group of several bison or moose installed in an eighteen-foot case can not look like anything but a crowded assemblage of mounted animals in a case. Such a group should not be attempted unless the space be available for a case at least fifteen by thirty, and even a larger area than this is better. Also, the larger the group, the more depth must be allowed from the glass to the background painting in order to get distance and illusion. In a general way, the proportion of double the depth works out well for length. This provides for a flat-curved background, as this form is better than a regular half-circle. This form of background also allows more foreground area than a regular curve. In order to conceal the ends of the painting where they join the front, the front sides of the group case are generally paneled, thus reducing the size of the glass. In the museum of the California Academy of Sciences, the large groups are about twenty-five feet long by twelve and one half feet deep, and plates of glass fifteen-by-ten feet, horizontally placed, raised about fourteen inches from the floor level, with paneled ends, were used. Holes were cut in the wooden

panels, glass inserted, and smaller groups with curved painted back grounds, built in boxes open at the top, set in position behind the glass, thus making use of this exhibition space, as shown Fig. 16.

The ceiling or wall space should also be made as high as possible and the painting run all the way up, so that in looking at the group, the visitor does not ordinarily see the actual top or end of the painting as shown in Fig. 17. The floor of the case should also be figured out beforehand, if possible, so that if a deep-water scene, like a hippo water group, is to be constructed, the floor level in the case should be lowered to allow for it. In constructing a group representing the side of a cliff, the floor of the case should be cut out to allow the cliff to run down so far that the actual bottom

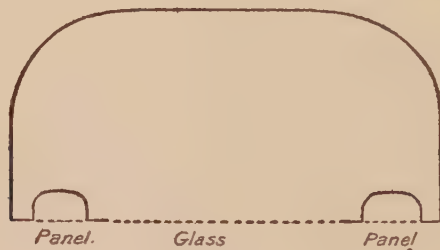


FIG. 16.—TOP VIEW OF BACKGROUND FOR A LARGE GROUP, WITH SMALL GROUPS INSERTED IN THE PANELS.

or ending of the cliff is not seen, in the same way as the top. To provide for these things adequately, it should be definitely determined beforehand just what is to go in each case, or certain cases at least, and the plans for the building drawn up accordingly. When large groups are exhibited, the hall should be made wide enough to permit a distant view of the picture, fifty feet being none too great. The majority of visitors will not avail themselves of distant view, it being the common custom for them to crowd as close as possible. In order to prevent them from actually bumping their heads against the glass, a low rail should be provided in front of each group. This also prevents them from rubbing their hands upon the glass and saves considerable time in cleaning it. Such an exhibition hall, as outlined in Fig. 19, would be ideal, and if artificially lighted would represent the last word in modern group exhibition of natural history objects.

Before the actual installation of a group can begin, the background painting must be provided for. In temporary exhibits, "ducking," or even heavy muslin is sometimes used, these being tacked to a frame above and below. The whole is then given a coat of thin glue size and, when dry, the painting is made with oil or water colors. When painted with oil colors, a large canvas hung

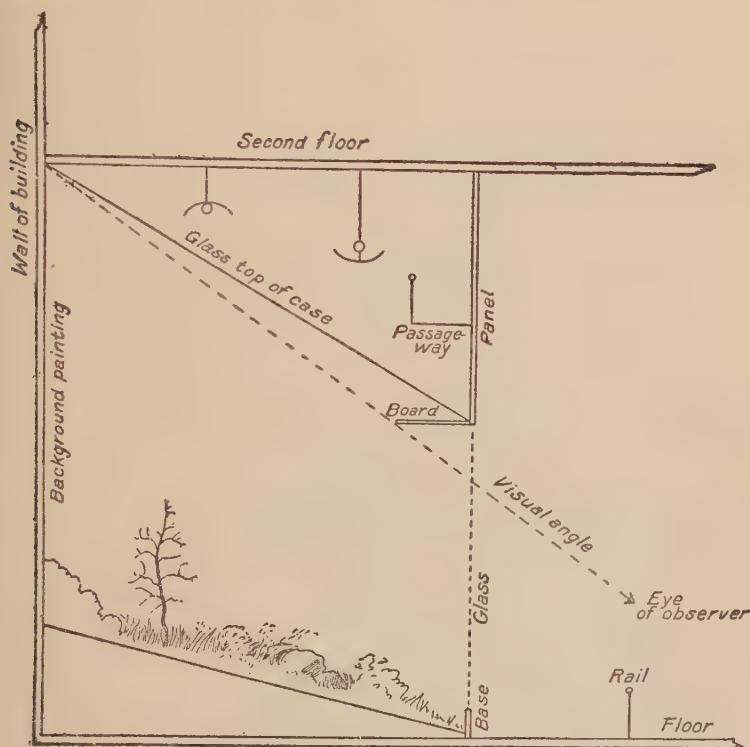


FIG. 17.—END VIEW OF MUSEUM GROUP.

on a curve "bellies" out in the middle, due to the weight of the cloth and paint, and is not entirely satisfactory. Large permanent curved group paintings are usually made on a plastered form and the painting done directly on the plaster surface, after this has received a sizing coat, and a second one of zinc white and linseed oil. Keene's cement or some other modeling composition is generally used instead of plaster, as the lime in plaster is liable to come through in time and decompose and discolor the paint pigment. A plaster or composition surface is not an ideal one upon which to

paint a picture, and should be covered with light ducking or heavy muslin, pasted on with zinc white and rolled smooth. A large painting on canvas should be made on the curve if it is to be exhibited that way. To paint a large picture flat and then install it on a curved surface, changes the direction of the horizon line and is not successful. For the best results, a painting should be made in the light in which it is to be exhibited. If for artificial light entirely, it should be painted under artificial light. The choice of colors should be left to the background artist, who should be competent to select such pigments as have the best reputation for permanency.

The plaster background, which is of wood or steel construction covered with galvanized wire cloth and a plaster composition, is more fireproof than some other materials, but since many of the objects introduced into the foreground are more or less inflammable, the matter of fireproofing the background frame and painting seems rather unimportant unless the foreground be also fireproofed. In world's fair exhibits, it is generally compulsory to fireproof all exhibits of an inflammable or combustible nature by spraying with an aqueous mixture, generally prescribed by the fair directors. The rules prescribed by the London Co. Council provide for spraying such objects with the following mixture:

Phosphate of ammonia (commercial) .	1	pound
Chloride of ammonia	2	pounds
Water	1½	gallons

It is not much trouble to spray a group with this solution by the use of a power spray, but how long such a spraying would retain its fireproofing qualities, I am not able to say.

A cheaper construction than plastering and one which answers every purpose, besides being very much lighter in weight, consists of running up two-by-four pine joists or scantlings, cross bracing, and covering with some form of plaster board, and smoothing over the joints with papier-mâché. When dry, this is painted with a glue size, and covered with six ounce "duck," wet, and pasted on with rye flour paste mixed with a little thin glue to strengthen it. The wrinkles are worked out by brushing with a stiff hand brush or a scrubbing brush. To join the pieces of canvas, allow the edges to overlap and cut through both thicknesses of cloth, using a straight-edge and sharp-pointed knife. When dry, this is again sized, and coated with light blue oil paint and when

dry, it is ready for the artist. This construction is light and inexpensive, but since all it has to support is an oil painting, it does not demand heavy construction.

In case the preparator prefers to make his own plaster board, or a better substitute for it, the following is recommended: Select a large smooth table, or nail together boards the length of the background space, plane them down and fill the joints so the surface is perfectly smooth, and give it a light painting with lard and stearine. Stretch a piece of wet thin muslin or cheesecloth across the board surface, tacking the edges all around and working out the wrinkles. Cover this again in the same way with thin galvanized wire cloth and spread and work on papier-mâché with a trowel, squeezing the composition through the meshes of the wire cloth upon the muslin. When dry, remove the tacks and lift the sheet off the boards. When placed in position, muslin side out, sized and painted, this gives an excellent surface for the artist to work upon and is so flexible that it may be nicely curved in any way and handled more easily than plaster board. For very small groups, there are several grades of cardboard or academy board that are suitable for background work, but these are limited in size. After being painted a light blue ground color, they are ready for the scene painter. For flat backgrounds, of course, the sheet of canvas, stretched and sized in the ordinary way, can not be improved upon.

The finest backgrounds are painted in oil color, and the artist should be made to understand thoroughly that his painting is only a background, pure and simple, and not a picture for the sake of the picture alone. It is designed as a continuation of the foreground to give depth to the latter, and one without the other is incomplete, the two in combination making up a finished whole. Large colored photographic enlargements on paper are used to some extent for backgrounds for groups, but they are simply a makeshift and done for cheapness. I have yet to see the colored photographic enlargement that looked like anything but what it actually was, and when completed, it is an open question as to whether any money has been actually saved by substituting an enlargement for a good oil painting. Furthermore, with a painting, greater freedom is allowed for values and composition; and the two bear about the same relation to each other as a cast and a piece of modeled sculpture. One is art and the other is process work.

For small groups, transparency backgrounds give excellent results. These are tinted photographic enlargements, either on glass or on a large sheet of celluloid; and the group is so arranged that most of the light comes from behind, showing through the background, and by proper lighting this may be brilliantly keyed up so so as to give beautiful effects.

In several museums, portable or "school cases" have been more or less used for a number of years past, the Field Museum in Chicago, through the Harris foundation, being perhaps the leader in this line of instruction. Portable groups are made for loaning and distribution in schools and other institutions, being transported to the classrooms, generally by automobile delivery, and circulated from one school to another, after the manner of a circulating library.

While director of the Oakland, California, Museum, the author gave the school case considerable attention, and many were made up, covering subjects such as birds, mammals, reptiles, insects, minerals, botany, and the manufacture of different articles from the raw material. This "traveling museum" soon became immensely popular and it was found that classroom instruction in the school, illustrated by visualizing and in many cases actually handling the objects, was much superior to bringing the student to the museum. Our experience was that when a class of students, accompanied by their instructor, visited the museum for a certain purpose, the students were apt to look upon the trip as a kind of holiday lark, and their attention, instead of being concentrated on the real object of their mission, was more or less distracted by new surroundings. On the other hand, when the subject matter, in the form of a compact, easily transported case was introduced directly into the classroom, it was something new there and thus had a deeper interest than the blackboard and books which were being used every day.

After experimenting with various types of case construction, the Oakland Museum finally adopted the one shown in Fig. 18, for the exhibition and demonstration of groups of birds, etc., which were not to be handled by the students. The wood adopted for the uprights was birch and these were shaped and run out in the mill. The back, bottom, and ends were made of three-ply panel stock, also cut to fit at the mill; and the edges of these fitted into

grooves or slots in the corner posts and were glued and nailed. To provide for both daylight and artificial lighting, the top was of glass and this was covered with a square of panel stock, hinged in front, and painted white on the back or inside to act as a reflector when raised. This reflector was held up in place with a wire prop at one end, so it remained at an angle of 45° on top of the case as shown in Fig. 18. For day lighting, the case was set close up to a window, the light striking the reflector and being deflected down

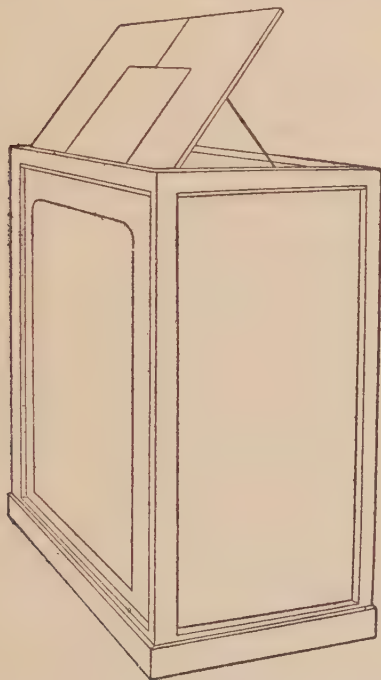


FIG. 18.—END VIEW OF SCHOOL GROUP CASE.

upon the background and foreground, lighted and keyed up both properly. For night illumination, an electric light bulb was hung behind the reflector. The top or face of the reflector gave ample room for the label or printed matter descriptive of the contents of the case; and during transportation and storage this was dropped flat upon the glass top to protect the latter from breakage and to save space. The background was painted upon a sheet of cardboard, cut to fit, and simply curled and slipped down into the case from the top before the glass was put in. The group itself was

built on a sliding tray, so the artist could slip the finished group in or out as desired, in making up the painted background. The front and top glass were simply held in place with wooden beads or stops, screwed into the wood of the case all around. To conceal the ends of the group and to take the place of the paneling used in large cases, before the front glass was put in, it was laid flat on the floor and sprayed with an air brush with zinc white oil-color paint all around the edges of a paper pattern laid flat upon the glass, the pattern being varied for different groups and tried out before spraying. This gave a ground-glass effect, but admitted light from the front to illuminate the ends, and gave an airiness to the case that could not have been gotten by paneling in wood. This type of case stood up well in handling, and was cheap, light, and strong. During storage, they were piled one upon the other, or if side by side they were illuminated with electric light bulbs hidden behind the reflectors and thus made to form a very attractive exhibit when not in circulation. The same type of case may be used for objects, such as minerals, mounted birds, etc., which are to be taken out and handled or passed around for inspection. These are fastened to the back of the inside of the case, on projecting shelves or otherwise, and attached with turn buttons, spring clips, or other devices, so they may easily be removed and put back into place again.

In designing groups, if the preparator is not able to conceive or form a mental picture of the group before he starts in to mount the specimens; or if he wishes to invite the help or advice of others, or to submit the scheme to some higher authority for approval, it is a good plan to first make a plasteline, or prepared clay, model of the proposed group, on a small scale. This may be changed or remodeled at will, until the arrangement is satisfactory to all concerned.

In designing animal groups, the preparator first of all should know his animal and its habits and surroundings. This knowledge is best acquired at first hand in the field, but if this be impossible, then all possible information from the next best source should be sought. In constructing a series of large mammal groups, it is a good plan, in order to have diversity, to work out different ideas in different groups. In one group, all may be lying down quietly; in a second group all may be standing bunched together, erect, and looking at some distant object, either in front of the case or in the

painting; a third may represent all or a portion of the animals quietly feeding, etc.

Violent action is better avoided. In painting or in sculpture, this may be done to a good purpose, as the piece represents only the subject and no illusion is intended. But to represent two mounted animals in violent action, as fighting each other, and no movement actually taking place, betrays at once that the thing is unreal. In taxidermy, the preparator deals with the animal itself, not a picture nor a model of one, and attempts to portray that animal as in life. Very clever illusions may be got in some instances where quiet attitudes are worked out, as in animals lying down, but the moment violent action is attempted illusion flies to the winds. Animals or birds showing action may be and often are well represented in a background painting, but they should be restricted to this and not mounted in the foreground of the group.

The matter of composition of a group is a most important one, and should be given full consideration before the animals are mounted. Without good composition, a group may be nothing but an assemblage of mounted birds or animals placed at random in a case. One of the worst faults in composition and assembling is repetition. This tendency must be carefully guarded against. If the artist be not careful, for instance, in painting a distant mountain range, he will make two or more peaks of the same general size and form and equidistant from each other. The same fault is commonly seen in placing birds and animals in a group. Many groups that I have seen look as if the specimens had been measured off and spaced with a yardstick. This is bad composition. The same thing holds good regarding the placing of accessory matter. To get the best effect from any one thing, it must be massed, just as landscape gardeners get their effects. If the reds, yellows, or other colors be spread around promiscuously, a pepper-box effect only is secured. Simplicity should be the rule rather than the assemblage of too great a variety of objects in any one group, and by all means *mass*. For example in the group of deer shown in the frontispiece, the mass of red poison oak represented at the right of the picture and continued into the background by the artist, gives its full effect in the group, both in color and composition, by bunching it in one large mass. Had this been separated and the small branches scattered about indiscriminately, the effect would have been lost.

In putting in the foreground, wherever possible this should be made to slope up to the picture as indicated in Fig. 17. If the flat foreground meets the painting at a square angle, a hole is created at the junction which is almost impossible to fill and have the painting continue the foreground without a break. Another great secret in making the background jibe with the foreground, is to paint in the background picture a continuation in duplicate of whatever is in the immediate foreground. In other words, if dry grass, a bush, or a rock come next the painting, in order to make the two come together, these objects must be exactly duplicated in whole or in part and carried back into the painting by the artist, as shown in the illustration of the deer group. After the union of foreground and background is complete, the artist is at liberty to work out the other details according to his own ideas, and the front of the foreground is not so important with respect to the background. In order to work out these details, at least enough of the foreground should be put in to enable the artist to see what he must duplicate, and the back portion of the foreground, or that adjoining the painting, should first be built and finished. In large groups a space sufficient for the artist to work in should be allowed between the foreground and the canvas; or a staging built over the foreground. In smaller groups, the foreground is made in sections or in one piece according to the size, and arranged to slide in or out so the artist can match up the details of uniting the two. If these rules be carefully followed and the artist and the preparator coöperate properly, the painting and the foreground may be so well matched and continued as to deceive the eye. When they are so well matched that the only way the junction may be determined is by looking intently at a certain spot along the union and moving the head from side to side, the job is a success.

Artificially lighted groups open up a broad field in museum exhibition, and with properly arranged overhead lights to destroy shadows on the painting, and concealed spot-lights, wonderful effects may be obtained that it would be useless to attempt by ordinary daylight; and the more beautiful the exhibits, the wider the scope of the museum in education and in popularity.

Group installation methods lend themselves to the exhibition of many classes of objects other than natural history, and the group idea should be followed for public instruction in museums wherever

possible. A good example of a historical group, for instance, is the colonial kitchen installed in the Oakland, California, Museum, by the late C. P. Wilcomb. This, by the way, is in every respect a most perfect masterpiece of high-class group installation. Here at a glance the visitor will see genuine samples of the home-spun garments and carpets made by our ancestors in early colonial days in New England; the spinning wheel; the pewter vessels; the blue china ware; the baby's homemade cradle; the open fireplace with the cooking pot hanging in position upon the crane; the old-fashioned prints upon the walls—in fact, the room is a perfect replica of the typical old-fashioned kitchen and living room of early colonial days. A second room fitted up as a colonial bedroom, with its high four-poster bedstead, etc., serves as an equally well appointed companion piece to the kitchen.

How much better this is than simply to have arranged all the articles displayed in these rooms in a glass case. No matter how carefully and artistically they might be arranged, nor how explicitly the descriptive labels might be gotten up, the average visitor would not carry away with him the details of the mental pictures of those rooms and the purpose and character of the objects displayed therein. Such pictures sink in and go home with the visitor. That is the prime object of a museum exhibit. Without this, the exhibit has failed in its purpose, and may just as well be dismantled and stored in the museum basement.

The Installation of Miscellaneous Objects in Exhibition Cases or Rooms.—In arranging a collection of small separate objects in a case or room designed for exhibition purposes, great care should be exercised that the objects be so placed as not to work out distinct patterns or designs. Straight lines are all right, but curves detract from the objects themselves and draw immediate attention to the arrangement pattern, which is apt to be the only thing noted by the average visitor.

In a well-known American museum, there exists at the present writing, a room containing an exhibit of firearms, spears, and other weapons, collected and installed by a competent collector who knew nothing whatever about the rules of exhibition installation. As a result, the first thing that catches the eye as one enters the room, is the mass of symmetrical designs, and even circles with spears and guns radiating from a common center like spokes in a wheel,

with which the walls are covered. This is bad installation and should never be allowed in any museum.

Whenever possible, different classes of objects should be segregated, or exhibited separately. One room or hall should contain, for example, birds only. A second should be given up entirely to shells or insects, and another section to mammals, etc. Where one hall is given over to the exhibition of a heterogeneous mass of objects, it becomes literally a junk shop; as such has but little value as a means of education; and is a failure. Furthermore, by the segregation methods, students or visitors are enabled to find grouped together the class of objects in which they may be specially interested, without having forced upon them other exhibits for which they may not particularly care. Recent skeletons are unsightly objects to the average museum visitor and should be exhibited by themselves if possible.

Explanatory Labeling.—Museum exhibits should, of course, be supplemented with good explanatory labels, telling in a straightforward way and without the use of any more technical or scientific terms than are absolutely necessary, as complete a short story as possible of the group. Long labels should be avoided, as they are tiresome to the ordinary visitor. The names of the artists and preparators should always be mentioned on the labels, whenever the exhibit is important enough to warrant it by showing superior or worthy workmanship, just as an artist or sculptor signs a finished piece of work. It acts as an incentive to better workmanship and is due the preparator.

In a group containing a variety of species, as for instance a colony of water birds of different kinds nesting together, rather than mar the group itself by indicating the names of the species, on numbers or names printed upon cards and set in the group, it is better to make a photographic enlargement of the group, number and name the birds, and frame it for use as a label in connection with the printed matter. Extraneous objects in the enlargement may be removed by tracing with waterproof ink each object to be retained, and then bleaching out the print in an aqueous solution of potassium cyanide. This bleaches out the silver and leaves only the inked outlines remaining. In addition to printed labels, good colored transparency photographic enlargements, set in windows or

GROUPS AND MUSEUM EXHIBITION

in front of artificial lights in panels, give excellent supplementary information and are always pleasing to the eye.

Museum Buildings.—The greatest trouble with museum buildings has been that the general plan has been left to an architect who knew nothing about the exhibition side of a museum and cared less. His sole idea was to erect a fine looking building—one which would be a monument to himself. The result has been that, when completed, the structure has utterly failed as an exhibition museum. If I had a museum to build, I would draw up a sketch plan of the interior and make it exactly as I wished the finished building to be. I would then submit the plan to an architect and ask him if he could erect the building exactly according to that plan. If he found fault with it and began to suggest all sorts of changes, I would at once drop him and consult others until I found one who would agree to put up the building exactly in accordance with *that plan*, and hold to it. If the architect is allowed to use his own ideas and make changes wherever he sees fit, by the time the structure is completed, it is an entirely different thing from the original plan, and therefore a failure. Architects have certain fixed “rules of architecture,” and most of them consider that to violate any of these rules is too radical a departure and must not be permitted under any circumstances. This has been one cause of the failure in the plan of most of the exhibition museums of the world.

Almost all objects in a museum must be exhibited under glass, and the primary rule in planning the exhibition halls should be to eliminate, or reduce to the smallest possible degree, reflections and cross reflections in the glass, so the objects exhibited may be clearly discernible. To install a series of objects in a table case with a glass top, to be viewed from above, and place the case directly under a strong top light, as is commonly done in many museums by incompetent exhibitors, is almost as complete a failure as if the objects were exhibited in the dark. Exhibits in a museum appeal solely to the eye, and unless they can be displayed so as to be plainly seen, they may as well be left out entirely. A real exhibitionist—one who has a knowledge of the rules and principles of exhibition, glass reflection, etc.—is rare. As the late Sir William Henry Flower rightly remarked, “It is not the objects placed in a museum that constitute its value, so much as the method in which

they are displayed and the use made of them for the purpose of instruction."

Up to about 1915, no museum building had been constructed especially for group exhibition, groups that had thus far been made having been installed in the various museum buildings wherever suitable space could be found to accommodate them. The first building to be planned for group exhibition solely, was the museum of the California Academy of Sciences, in San Francisco. Mr. Leverett M. Loomis, then director of that institution, induced the trustees of the academy to construct such a building in Golden Gate Park, San Francisco, and in 1916 the author and assistants installed the group series now on exhibition there. They were elaborately done with modeled foliage and painted backgrounds, the latter executed by such well-known artists as C. A. Corwin, Maurice G. Logan, Capt. Chas. B. Hudson and others; the bird groups being the work of Paul J. Fair. These groups set the museum world a pace for large group exhibition, and while far short of perfection in many ways, they were a long stride in the right direction.

The Academy building is constructed with skylights allowing for only top day lighting of the groups, and no side windows, the groups being arranged against the walls surrounding a central hall, and the only light in the hall being that which comes through the glass fronts of the groups. Artificial lights for night exhibition were installed, and after a careful study and comparison of the two methods of lighting, the author was firmly convinced that artificial lighting exclusively for both day and night exhibition was preferable, not only for the enhanced effect of artificial light upon the group and the ease with which it may be controlled, but also for the non-bleaching qualities of electric light as compared with daylight. Daylight will fade colors, and the nearer the object is to the source of light—as that from a window—the more rapidly the violet rays get in their work and bleach the colors. Ground glass to some extent prevents bleaching but does so solely by reducing the volume or intensity of the light. To my knowledge, no non-actinic glass has yet been discovered that will filter daylight rays so as to prevent ultimate bleaching, and at the same time give a white light. To collect and install a large group, with carefully mounted specimens, artificial accessories, and a painted background

may cost several thousand dollars, depending upon its size and elaborateness. To construct such an exhibit and expose it to strong daylight is a waste of time and money, if the exhibit is designed to be a permanent one. It is bound to fade in time and the whole thing is not worth while.

With artificial light the fading or bleaching is reduced to a minimum and during non-exhibition hours, the lights are turned off, leaving the groups in absolute darkness. The group of deer shown in the frontispiece was mounted and installed in the Oakland, California, Museum by the author and assistants in 1917, and is almost entirely lighted with top electric light. At the present writing, 1924, this group is as bright as it was the day it was finished; whereas the groups in the California Academy of Sciences, after only eight years' exposure to top daylight, already show the bleaching effects of daylight.

The Los Angeles Museum, in the building now being erected for the proposed African hall to exhibit the African mammals collected and presented by Mr. Leslie Simson, is planning, somewhat as shown in the sketch, Fig. 19, for entirely artificial light, as the board of directors was easily convinced by the author that artificial light entirely was the only thing for proper effect and permanency.

Furthermore, by day lighting with top light, the shadows fall straight down and the groups are thus more or less limited to mid-day scenes; whereas by a system of artificial lighting, different effects may be worked out, such as sunrise, sunset, or moonlight scenes. In a polar bear group with icebergs and floes, changing lights giving the effect of the Aurora Borealis might even be successfully rendered.

Artificial light is, of course, more expensive to maintain, both in electric current and in the constant replacement of bulbs; but in a well balanced museum of natural history, artificially lighted groups should not constitute the only exhibit, and many interesting and instructive stories may be told with objects that do not require artificial light and are in fact better exhibited by daylight. One wing of a museum devoted to the orders of the animal life of the earth, showing the evolution and gradation from the sponges to man, would be ideal. The sketch shown in Fig. 20 provides for both systems of lighting, and embodies the author's ideas of what a modern museum structure should be.

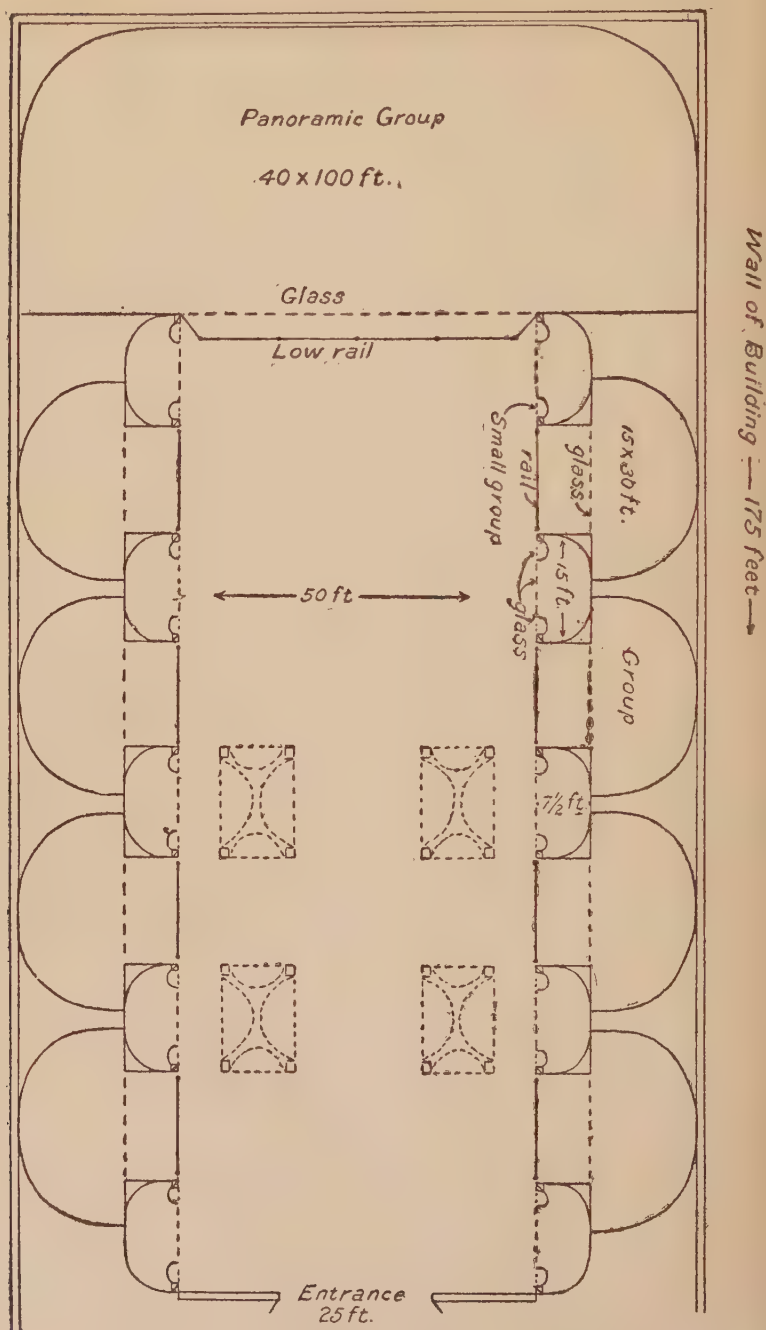


FIG. 19.—SKETCH PLAN FOR ARTIFICIALLY LIGHTED GROUP HALL FOR BIRDS, MAMMALS, ETC.

Another method of exhibition that has good features, is to break up the central hall or floor space with columns, as shown by the dotted lines in Fig. 19, so the visitor does not see the whole hall at one time, but sees rather a series of vistas or distant views, which are enhanced by looking through the openings between the

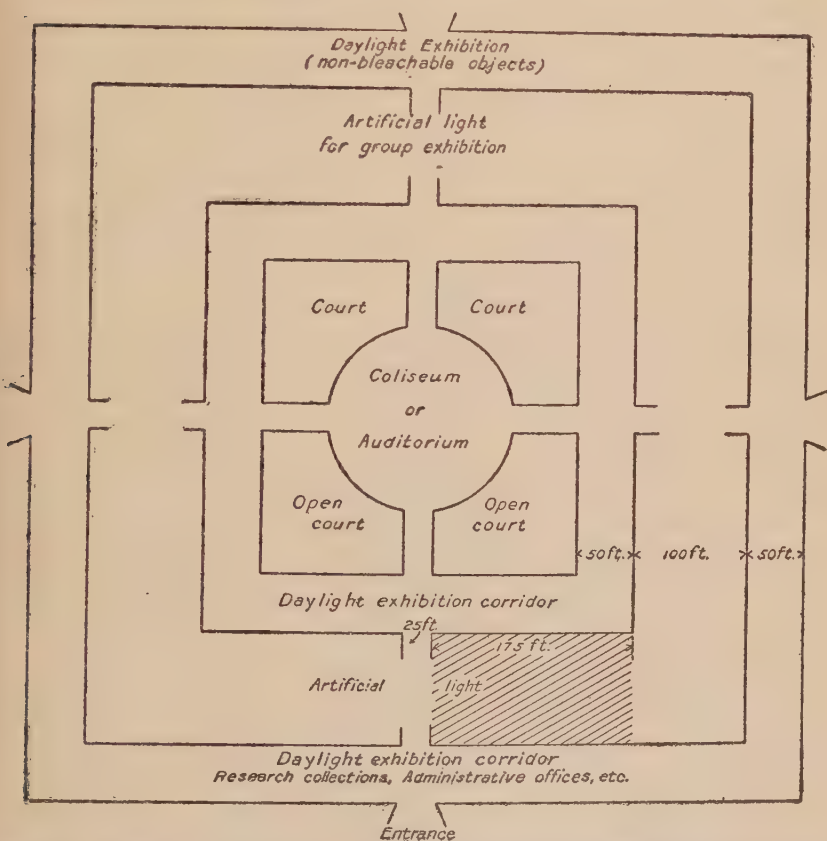


FIG. 20.—PLASTIC SCHEME FOR A MUSEUM STRUCTURE EMBRACING BOTH ARTIFICIAL AND DAY LIGHTING. FIGURE 19 INDICATED IN SHADED AREA

columns, and which suggest looking out through windows in the sides of the building. To make more exhibition room, the spaces in the columns are utilized for groups, transparencies, or transparency groups, all being artificially lighted. According to the plan shown in Fig. 20, the building may be erected in units spreading over a period of years, as the necessary money became available. If but a comparatively small sum of money is on hand for building pur-

poses, and it is desired to erect one group wing, this may be roughly built in concrete and without any finish to the exterior walls. It may then be roofed over and permanent exhibits installed. At any future time, the real building may be constructed around this, and the architects permitted to erect for themselves as large or as fine a monument of architecture as the administrative board of the museum will pay for, being perfectly free to put in windows and whatever architectural design they may decide upon. Such a building is suitable for and should only be erected in a park or square large enough to afford complete isolation from fire from adjoining buildings. Even though the building itself may be made absolutely fireproof, in the event of a large conflagration in adjoining buildings, the contents of a museum could be charred, incinerated, and rendered worthless.

One of the greatest mistakes that the founders of a museum can make is to start the first unit on a piece of ground that is too small to allow for future expansion. A museum, like a tomb, is built for all time, and as it becomes over-crowded with exhibits, more ground room for building is required. If this can not be acquired, the building has reached its limit of expansion and remains as a dwarf there; or, as happened in the case of the British Museum, the activities of the institution must be divided and a separate building provided at a more or less remote distance from the parent, to house some branch of the collections.

The proper founding of a museum is all-important. A museum which is built and owned entirely by a municipality is a purely political institution and as such will in all probability never expand and develop into a great institution. xBoth the heads and the employees owe their positions to political influence, and qualification in many instances is not considered.' The man with the biggest "pull" gets the "job."⁴ Such an institution is almost entirely dependent upon municipal appropriations for its maintenance and the city authorities who furnish the money rarely know anything about the demands of a museum or how the funds should be spent. It is difficult to solicit outside aid for further support or for special exhibits, as people generally do not care to donate money directly to a city or county. The second method of founding a museum is for the municipality to furnish the ground and buildings, with guaranteed annual appropriations for their maintenance and expan-

sion, and with the understanding that the ownership of the collections be vested in a board of governors or trustees; and the scientific and preparatory staffs furnished, controlled, and supported by the income from an established founding fund gathered by the trustees, which may be augmented by gifts, bequests, or endowments, the whole institution being governed by a president and board of trustees selected by the museum membership at a periodical election. The third, and by all odds the best method of founding a museum is by private capital. Then politics are kept out entirely. By this method, one man's money buys the land, erects the building, and equips it, besides maintaining the scientific and exhibition collections, enough money being left and invested so that the income or proceeds are sufficient to run the institution properly. Such an arrangement is good provided a sufficient sum of money be left as a permanent endowment fund to meet the running expenses. This fund must be carefully guarded, otherwise depreciation or bad investments and a consequent shrinkage of income leaves the museum without sufficient funds to carry on its work. An institution founded in this way can successfully solicit outside support, provided it does not bear the name of the founder. An institution named after its founder is looked upon as a monument to him and other people seldom care to add to it by gift or bequest. But if the founder be broad enough to furnish the funds without tying his name to it, there will probably be no trouble in securing other money, as it is required, from outside sources to build up the institution, and there is no limit to its future expansion and prosperity.

Museum Administration.—Another mistake that is quite common is for museum founders to try to combine art, history, and science in one institution and under one head. This is one of the greatest misfortunes that could befall any museum, and if started in this way, the sooner the charter is amended so as to eliminate one or the other, the better for the institution. They have nothing in common and there is a continual fight between the heads of the various departments. Furthermore, the type of exhibition hall and the lighting system demanded for painting and sculpture will not in most cases answer for natural history objects. Two directors are then necessary, as the museum director is not yet born who can successfully handle and build up both art and science.

One word as to museum directors. The common mistake is to select a museum director from the ranks of scientific men. No greater error can be made. The director or head of a museum should be a well-educated, broad-minded business man of good personal appearance and "mixing" qualities, without any leaning toward any particular branch of museum work, so that no favoritism may be shown one department at the expense of another. His duties should be to look after the large affairs of the institution, to meet and interest people, and get donations and bequests, and otherwise build up the museum. A director who has spent a term of years in an institution has been simply a time-server if the building has not grown or expanded during his administration. He is much like a parson who spends a lifetime in one small church. If he were any good, the old church would long ago have been pulled down and replaced with a finer and larger one.

The administrative board of the museum should then place at the head of each department a man who is a specialist in his own line, and back him up to the limit in whatever was best for the development of that department in organizing and carrying on the work. But unfortunately, in many cases, the director considers that because he has been chosen as the head of the institution, he must dictate to the specialist, even though the latter may have forgotten more than the director ever has or ever will know about the matter. This causes discontent and ill-feeling, and gnaws directly at the foundations of the progressiveness of the institution. It destroys absolutely the one thing without which nothing great can ever be accomplished—*coöperation*. Fighting destroys; coöperation builds. Thus, one of the chief duties of a competent museum director should be to produce sincere coöperation on the part of every person connected with the institution, to eliminate all jealousies, advance the salaries, and have everybody working for one grand cause—the advancement and upbuilding of the museum. For the more museums, school houses, churches, and other institutions there are for the education and enlightenment of humanity, the better.

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